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Factors Influencing the

PALATABILITY, VITAMIN CONTENT, AND YIELD OF COOKED BEEF

Home Economics Research Report No. 9

Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

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Factors Influencing the PALATABILITY, VITAMIN CONTENT, and YIELD of COOKED BEEF

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Home Economics Research Report No. 9

Human Nutrition Research Division

Agricultural Research Service

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FACTORS INFLUENCING THE PALATABILITY, VITAMIN CONTENT, AND YIELD OF COOKED BEEF

By Elsie H. Dawson, Grace S. Linton,[3] Alice M. Harkin, and Cora Miller,[3]
Human Nutrition Research Division, Agricultural Research Service

SUMMARY

Cuts of beef of Good grade and below were generally satisfactory in eating quality even when cooked by methods heretofore customarily reserved for Prime or Choice grades. The fat content of these meats was lower, as a rule, than for the Prime or Choice cuts.

Dry-lot finishing resulted in animals with somewhat more marbling of fat in the meat than animals slaughtered off grass. When comparable cuts were cooked under standardized conditions, the meat from the animals from dry-lot finishing was rated similar in flavor but slightly higher in tenderness and juiciness.

Palatability scores for tenderness and flavor were in favor of dry-heat cooking for each market grade when corresponding cuts of round of beef were cooked by dry- and moist-heat methods to the same end-point temperature of doneness. When cooked to different end-point temperatures, round steaks were significantly better in all palatability factors when roasted to 160° F. than when oven-braised to 176°.

Beef pressure-braised to 176° F. was rated more tender but less juicy and flavorful than beef oven-braised to the same temperature. When pressure-braised to 185° beef round was rated lower in tenderness, juiciness, and flavor than when oven-braised. Pressure-braising to 216° resulted in more palatable meat than oven-braising to 209°.

Tenderness of beef did not increase consistently with increased hydrolysis of collagen. Although the amount of intramuscular fat is a factor affecting the tenderness of beef, internal temperatures and resultant cooking losses exerted more influence on juiciness than did the fat content of the raw beef. The quantity of fat is not necessarily an indication of meat flavor, since the fat of cuts from different animals might vary in character and in flavor.

There was no evident advantage in holding Commercial-grade cow beef longer than 7 days in cold storage. Increasing from 7 to 21 days the length of storage at 32 to 34° F. did not increase the tenderness of steaks and resulted in lower scores for flavor and juiciness.

In tenderness, juiciness, and flavor, there was little difference between frozen beef cooked without thawing or after thawing in the refrigerator and that cooked unfrozen, either when oven-braised to 209° or when pressure-braised to 216° F.

Application of enzymes to the surface of the meat increased the tenderness at a possible sacrifice of juiciness and flavor. Vinegar as a tenderizer was definitely undesirable. Pounding the meat increased its tenderness slightly.

Differences in retention of vitamins between dry- and moist-heat methods of cooking beef were influenced by interrelations of method of cooking, thickness of cut, muscle, time, temperature, and drippings loss. Retention of thiamine was consistently higher but retention of riboflavin was consistently lower in oven-braised than in pressure-braised cuts. Differences in retention of thiamine and riboflavin after cooking meat--unfrozen, refrigerator-thawed, or thawed during cooking--were too small to be of statistical significance.

Yields of cooked meat were higher from braising than from broiling, and for the most part were higher from oven-braising than from pressure-braising. Yields of meat cooked by roasting or braising varied with the cut and the conditions of cooking time and temperature. Cooking losses appeared to be lower in Prime and Choice grades than in the lower market grades of beef.

---

[3] Grace S. Linton and Cora Miller have resigned.

PLAN OF STUDIES

Although a substantial part of the beef on the market is of U. S. Good grade and below, few studies have provided information on the best household use of beef of this type. Research was needed to determine the methods of home cooking most suitable for different cuts of lower market grade.[4]

Tenderness, juiciness, and flavor are considered the most important characteristics in evaluating the eating quality of meat. Generally, more attention is given to tenderness than to the other characteristics, since juiciness can be enhanced by liquids and sauces and flavor be altered by browning and seasonings, whereas, meat too difficult to chew is rejected by the consumer. Juiciness and flavor should not be overlooked, however, since previous work has shown that cooked meat may become unpalatably dry and lacking in flavor.

It has become customary in this country to use dry-heat methods of cooking only for certain cuts of beef, such as rib and loin, and moist-heat methods for all other cuts. This practice has been based on assumed differences in the tendering effect of the two methods as well as on differences in composition of the raw cuts. However, little research-based evidence to support this assumption is available.

To provide data on this subject, various cuts of beef of different grades were cooked both by commonly used dry-heat methods--roasting and broiling--and by moist-heat methods--braising on top of the range, in an oven, and in a pressure cooker. Three common methods of determining doneness were used--internal temperature of the meat, change in color, and ease of penetration when pierced with a fork.

Quality of paired cuts of beef of Good, Commercial, and Utility grades was compared, when cooked by moist-heat methods, which are usually recommended for these grades, and by dry-heat methods, favored mostly for the higher grades of Prime and Choice.[4] The cuts used were from steers and cows of various ages. Some were grass fed and some were finished with dry-lot feeding. Thus, the raw meat differed in fat content and other components that affect the palatability and nutritive value of cooked meat. Since considerable attention is currently focused on consumer demands for meat with less fat, the data on grass-fed beef, or less well finished beef, are of particular interest.

In some of the studies the cuts of Good and lower grade were compared with those of Prime or Choice beef. Data on cooking losses and yields of cooked meat also were obtained in some instances.

This publication summarizes results on the effect of various methods of home cooking on the palatability, vitamin content, and yield of cooked beef from research carried out under contract or cooperative agreement with the United States Department of Agriculture at the University of Chicago (hereafter referred to as station A), the University of Georgia (station B), Iowa State University (station C), Kansas State University (station D), Michigan State University (station E), New York State College of Home Economics (station F), and Texas Agricultural Experiment Station (station G). Publications that report various phases of the research in greater detail are listed on page 39 - - (7, 8, 9, 10, 11, 12, 14, 15, 20).[5] Data are summarized in tables 1 to 28 and figures 1 to 19 with a brief discussion of the highlights of the research.

In Appendix A are described the experimental procedures used at the different stations for cutting and cooking the beef for panel evaluation of palatability. The methods used for physical and chemical determinations of quality are summarized in table 29, also in Appendix A.

Available information on the history of the animals from which the beef for the experiments was obtained is outlined in Appendix B (table 30). Inasmuch as the U. S. system of grading was revised during the course of the work, the table also indicates market grades according to both sets of specifications. The effect of type of feed on composition and palatability of beef also is discussed in Appendix B and data are present in tables 31 through 34.

At all stations, palatability ratings were evaluated on a 10-point scale, although descriptive terms attached to the numerical ratings were not always the same. The difference in scores between cuts is used in some of the tables and figures to express comparative results from more than one State, because the level of scoring on the 10-point scale may have differed at the various stations.

The basic data from the studies are given in Appendix C (tables 35 through 43).

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[4] Grades used in this publication were in effect December 1950 to June 1956; animals under 48 months of age in Commercial grade would now be graded Standard (See p. 48).

[5] Underlined numbers in parentheses refer to Literature Cited, p. 39.

RELATIVE PALATABILITY OF DIFFERENT GRADES OF BEEF

Retail cuts of beef of Good grade and below were almost as satisfactory in eating quality as those of Prime or Choice when cooked by braising. When cooked by roasting, tenderness scores of beef graded Good and below were not as high as scores for Prime or Choice grades. The majority of cuts of Good grade and below were rated average or above in flavor, juiciness, and tenderness.

Four of the stations in this investigation evaluated cuts from animals grading Prime or Choice, in addition to those of lower grades cooked by comparable methods. Grade, fat content, palatability, and cooking loss of selected cuts of steer and cow beef are given in table 35. Relations among grades of beef are shown in table 1. Panel scores for Prime or Choice cuts were considered as reference standards and

TABLE 1.--Relative fat content and palatability of selected cuts of beef of different grades

Cooking method, cut, and grade	Animals	Fat content, raw, as related to that for Prime grade, moist basis	Palatability value as related to that for Prime or Choice grade		
			Tenderness	Juiciness	Flavor
BRAISED:					
Top round:	*Number*	*Percent*	*Percent*	*Percent*	*Percent*
Prime..............	4	100	100	100	100
Choice.............	7	[1] 56	97	84	97
Good...............	5	[1] 43	83	87	92
Commercial.........	29	46	84	82	88
Utility............	6	[1] 60	89	74	80
Cutter.............	1	11	85	75	82
Bottom round:					
Prime..............	4	100	100	100	100
Choice.............	7	[1] 53	108	100	97
Good...............	5	[1] 57	93	98	95
Commercial.........	28	49	84	86	88
Utility............	6	[1] 44	90	89	87
Cutter.............	1	11	66	68	74
ROASTED:					
Chuck:					
Choice.............	1	--	100	100	100
Good...............	1	--	43	77	109
Utility............	2	--	91	89	91
Rib:					
Prime..............	2	100	100	100	100
Choice.............	1	--	66	81	77
Good...............	3	[1] 52	79	102	88
Commercial.........	13	59	89	97	90
Utility............	2	--	59	105	83
Loin:					
Prime..............	2	100	100	100	100
Good...............	3	[1] 57	92	108	96
Commercial.........	13	56	89	108	94
Utility............	1	--	64	127	92

[1] Fat values for top and bottom round are averages for 6 animals graded Choice, 4 graded Good, and 4 graded Utility; those for rib and loin cuts are averages for 2 animals graded Good.

assigned values of 100 percent, and the palatability characteristics of cuts of lower grade were calculated as a percentage of the values for the higher grade. The relative fat content of high- and low-grade beef was calculated in the same manner.

Generally, fat content of the raw meat, as well as values for tenderness, juiciness, and flavor of the cooked meat, was higher for Prime or Choice cuts than for cuts of lower grades. Roasted rib cuts of Good and Commercial grade were an exception; they scored relatively higher than Choice rib cuts for all palatability characteristics on a percentage basis.

The panel scores from this phase of the study, in addition to providing a basis for comparing Prime or Choice with the lower grades of beef, are an indication of the degree of acceptability of cuts of Good grade and below as cooked in this investigation. In table 2 are shown the percentage of average palatability scores for cuts of Good and lower grades that fell in three range categories of which the middle category--5.0 to 6.9 on a rating scale of 0 to 10--was variously described as "average," "medium," or "medium minus." From this distribution it is evident that the majority of cuts scored the equivalent of "average" to "good" or "excellent" (7.0 to 10.0) in tenderness, juiciness, and flavor. Only in the round cut was flavor rated within the range of "very poor" to "fair" (1.0 to 4.9) and only 3 percent of the ratings were in this range. Round, chuck, and loin

TABLE 2.--Percentage of average scores for beef of Good grade and below falling within three range categories in tenderness, juiciness, and flavor[1]

Cut and range of average score	Tenderness	Juiciness	Flavor
Round:	*Percent*	*Percent*	*Percent*
1.0 to 4.9	15	33	3
5.0 to 6.9	56	55	57
7.0 to 10.0	29	12	40
Heel of round:			
1.0 to 4.9	--	--	--
5.0 to 6.9	100	100	50
7.0 to 10.0	--	--	50
Rump:			
1.0 to 4.9	--	--	--
5.0 to 6.9	25	100	--
7.0 to 10.0	75	--	100
Chuck:			
1.0 to 4.9	9	9	--
5.0 to 6.9	59	86	59
7.0 to 10.0	32	5	41
Sirloin and sirloin tip:			
1.0 to 4.9	--	--	--
5.0 to 6.9	25	100	12
7.0 to 10.0	75	--	88
Loin:			
1.0 to 4.9	25	25	--
5.0 to 6.9	25	37	25
7.0 to 10.0	50	38	75
Rib:			
1.0 to 4.9	--	--	--
5.0 to 6.9	50	83	17
7.0 to 10.0	50	17	83

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[1] Includes all cuts of beef in appendix tables 36 and 37.

were the cuts with 9 to 33 percent of the tenderness and juiciness scores in this category. All scores for heel of round, rump, sirloin, and rib were in the range of average or good to excellent.

The fact that cuts of grades below Prime, which at most contained only 60 percent as much fat as the top grade, were relatively tender, juicy, and flavorful, indicates that eating quality can be satisfactory in cuts from animals somewhat less well fattened than the Prime grade.

Among the braised cuts, by far the lowest relative ratings were obtained from bottom round of Cutter grade, as might be expected. Among the roasted cuts, relatively lower tenderness values were obtained from rib and loin of Choice and Utility grades and chuck of Good grade than from the cuts of higher grade. Juiciness values for rib and loin did not decrease with a lowering in grade. Only in the Choice rib cuts did relative flavor ratings fall below 80 percent of that value for Prime grade.

FACTORS AFFECTING THE PALATABILITY OF BEEF OF GOOD GRADE AND BELOW

EFFECT OF COOKING METHOD

Palatability scores, averaged for a cut or muscle according to the grade of beef and method of cooking, are given in tables 36 and 37. Further relationships of the cooking methods, including cooking time and end-point temperatures, to palatability and chemical composition are shown in tables 38, 39, and 40.

In figures 1 through 6 the differences in scores between paired cuts cooked by different methods are shown under the method that received the higher score. From this arrangement can be seen which method of cooking, if any, was superior. Tenderness, juiciness, and flavor of the cooked cuts were rated by a tasting panel; objective measurements of tenderness and juiciness also were made.

Dry- and Moist-Heat Methods of Cooking Compared

Palatability comparisons of corresponding cuts of beef round cooked by dry- and moist-heat methods to the same end-point temperature of doneness showed that differences, where found, in scores for tenderness and flavor were in favor of dry-heat cooking. When cooked to different end-point temperatures, round steaks roasted to 160° F. were significantly better than those oven-braised to 176° in all palatability factors.

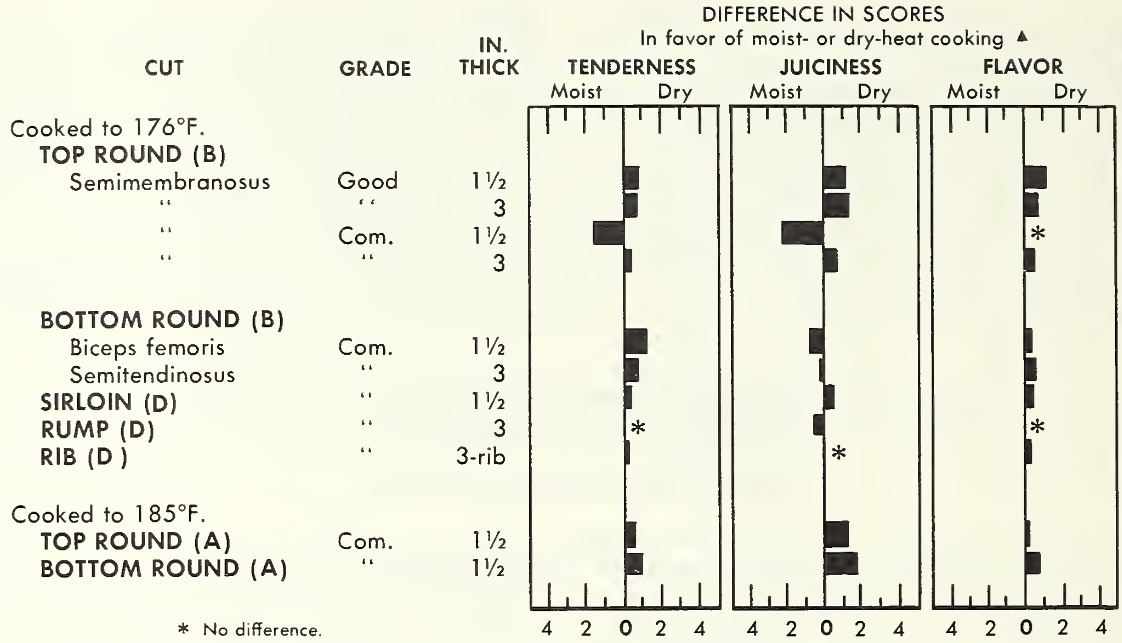
Cuts cooked to the same end-point temperature.--The palatability of paired cuts of Good and Commercial grade steer beef cooked by dry- and moist-heat methods to the same degree of doneness as measured by the internal temperature of the meat were compared at three stations.

The differences, if any, in scores for both tenderness and flavor were generally in favor of dry-heat cooking for two temperatures of doneness, 176° and 185° F. (figure 1). Thick and thin cuts of bottom round rated appreciably higher in juiciness when cooked with moist heat, whereas thick cuts of top round rated higher when cooked with dry heat at station B. Similarly, at station D dry-heat cooking was generally preferred when paired cuts were cooked to 176°, though on an average differences were not great. Top and bottom rounds both scored higher in all palatability factors when roasted than when braised to 185° at station A.

Thus it might be concluded that roasting or broiling cuts of Commercial or Good grade steer beef at 300° to 350° F. to an internal temperature of 176° or 185° could be expected to give meat as tender and flavorful as braising and in most cases probably just as juicy.

Cuts cooked to different end-point temperatures.--It might be argued that with dry- and moist-heat methods of cooking, different internal temperatures of doneness would be desirable. If so, there remains the question of what internal temperatures should be considered satisfactorily comparable in doneness. In one study at station E, 160° F. for dry-heat and 176° for moist-heat cooking were used as internal doneness temperatures for 1-inch steaks.

On the other hand at station G, where the panel preferred very well-done meat, degree of browning was used as the end point of doneness for broiled 3/4-inch cuts and fork tenderness obtained after 45 minutes' cooking for braised paired cuts. Of the thick cuts, oven roasts were cooked to



▲ Moist heat includes braising on range at 212°F. or in oven at 300° or 350°; dry heat includes broiling or roasting at the same oven temperature used for paired braised cuts.

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FIGURE 1.--Comparison of moist- and dry-heat methods of cooking steer beef to the same internal temperature.

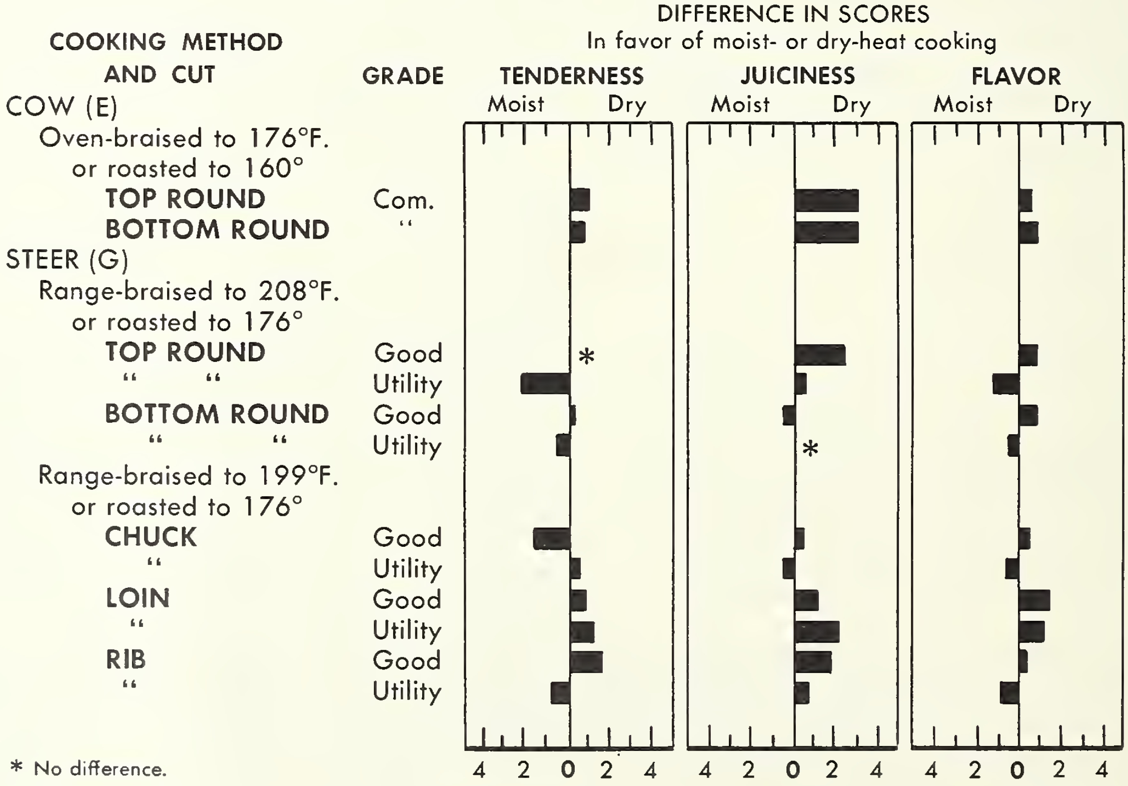

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FIGURE 2.--Comparison of moist- and dry-heat methods of cooking cow and steer beef to different end-point temperatures.

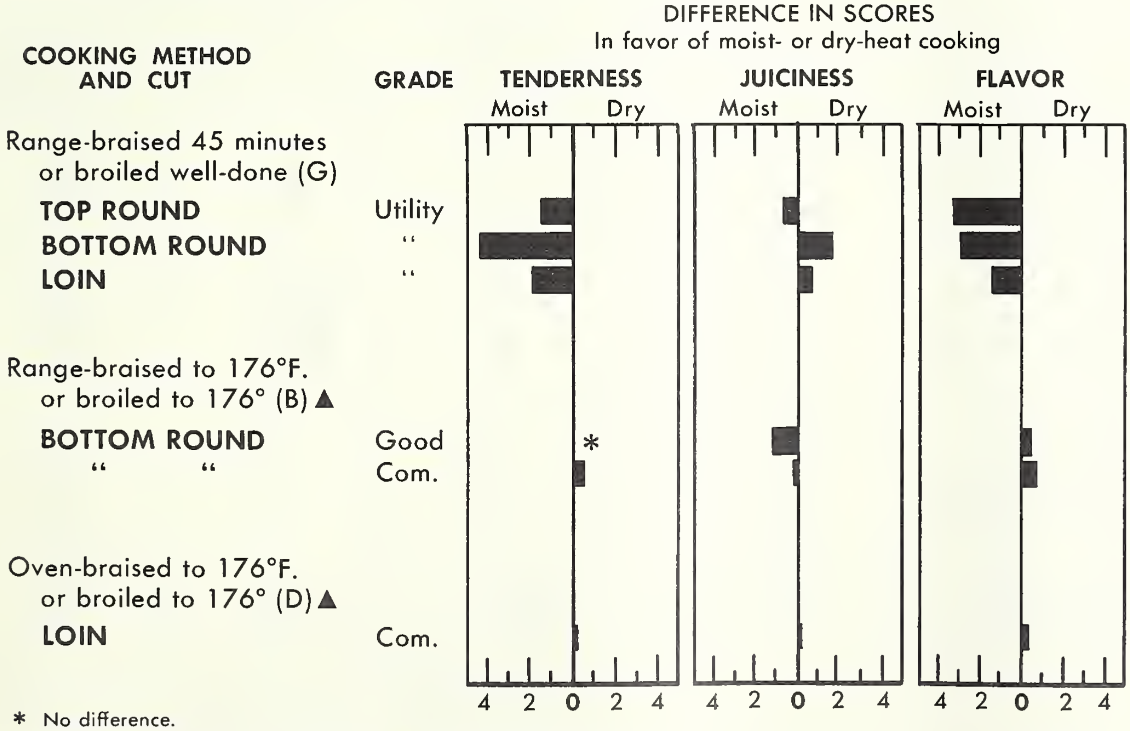
an internal temperature of 176° and braised roasts to 199° or 208°.

Even for the 1-inch steaks from the different muscles of top and bottom round of cow beef at station E, average panel scores on all palatability factors were higher for muscles cooked by dry heat to 160° F. (figure 2). Juiciness was also considered appreciably better when muscles were cooked by dry heat. Analysis of variance showed statistically significant differences between these methods of cooking for all palatability factors except flavor of the adductor muscle. Both tenderness and flavor of the semimembranosus muscle were significantly different at the 5-percent level, while all others were significantly different at the 1-percent level.

Bottom rounds of steer beef were more tender and had better flavor when braised to 208° than when roasted to 176° F.; however, loin was scored higher for all palatability factors when roasted. For the top round, chuck, and rib, there were no consistent differences in these factors between dry and moist methods when different end points were used. While the data for tenderness and flavor followed no particular trend, 11 of 18 thick cuts cooked by dry heat were scored higher in juiciness than their braised paired cuts. This result may have been due to the higher internal temperature of the braised meat, since the other experimenters have shown that a decrease in juiciness accompanies an increase in internal temperature.

As shown in figure 2, station E found that small thin pieces of cow beef rounds would be somewhat more tender, definitely more juicy, and preferable in flavor if roasted at 450° F. to an internal temperature of 160° than if braised to 176° in a 250° oven. At station G differences in palatability ratings between cuts of chuck, loin, and rib of steer beef 2-1/2 to 3 inches thick tended to favor the dry-heat methods.

When three thin cuts from Utility grade steers were broiled very well done, as shown in figure 3, the panel rated them definitely less desirable in tenderness and flavor than their paired cuts braised 45 minutes to fork tenderness (station G). Nevertheless, both bottom round and loin were considered more juicy when broiled than when braised to these end points. It would seem that if very well-done meat is preferred, a more tender and flavorful product of thin cuts would be obtained from prolonged braising.



* No difference.

▲ Range-braised at 212°F.; broiled at 350°; oven-braised at 300°.

DN-1725

FIGURE 3.--Comparison of braising and broiling steer beef to different end-point temperatures.

On the other hand, with Good and Commercial grade meat, differences if any shown in figure 3, indicate that bottom round steaks were more tender and flavorful but less juicy after broiling at 350° F. to 176° than when range-braised at 212° to the same internal temperature (station B).

Loin steaks of Commercial grade were slightly more tender, juicy, and flavorful when broiled than when oven-braised to 176° (station D).

Different End-Point Temperatures Compared for Same Method of Cooking

Braised cuts of round from steer beef tended to be about equally tender and flavorful and more juicy when cooked to low rather than to high end-point temperatures. Also, cuts of loin, rib, or round cooked by broiling or roasting generally were more tender, juicy and flavorful when cooked to the lower end-point temperatures of 158° or 160° F. than to the higher temperatures of 176° or 194°.

Braised cuts.--A comparison of cuts from the round cooked by braising to different internal temperatures is shown in figure 4.

At station C the size of the muscle cuts varied among animals according to their age, ranging from 1 or 2-1/2 pounds for the semitendinosus from 6-month-old steers to 4 or 8 pounds for the semimembranosus from animals 42 to 48 months old. Panel scores were averaged for muscles used and for the grade of beef to compare differences in palatability between paired cuts oven-braised to 158° or 194° F.

Differences in tenderness between paired cuts braised to different temperatures were generally very slight and in only 2 of 6 comparisons were cuts cooked to 194° F. considered more tender than their paired cuts cooked to 158°. However, all cuts cooked to 158° were rated appreciably more juicy, and all but semitendinosus muscle of Good grade were more flavorful.

The palatability of rounds braised to different temperatures within the range considered well done was compared at station A. Matched 1-1/2-inch steaks cut from top and bottom rounds of Commercial grade beef were cooked to internal temperatures of 176°, 185°, or 199° F. Differences in their average scores are presented in figure 4. All cuts cooked to 185° were preferred in flavor. Although there seemed to

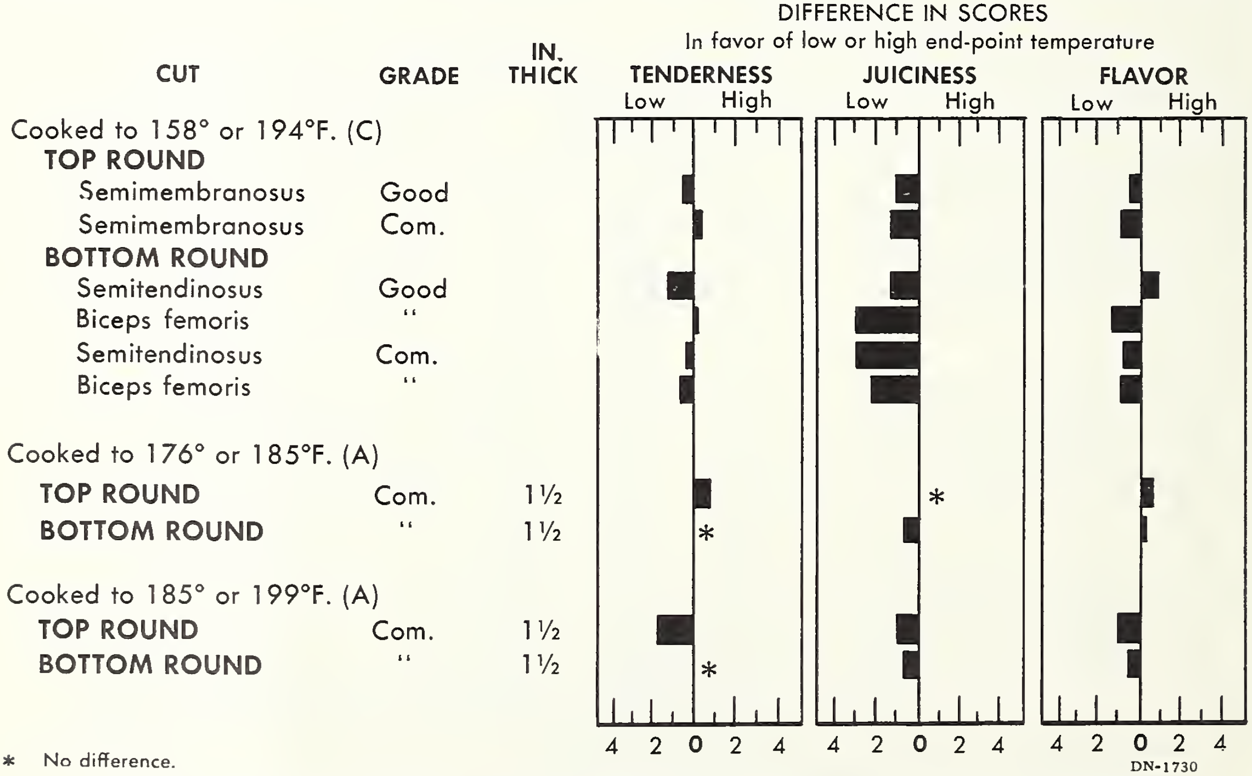


FIGURE 4.--Comparison of different end-point temperatures of doneness for steer beef oven-braised at 300° F.

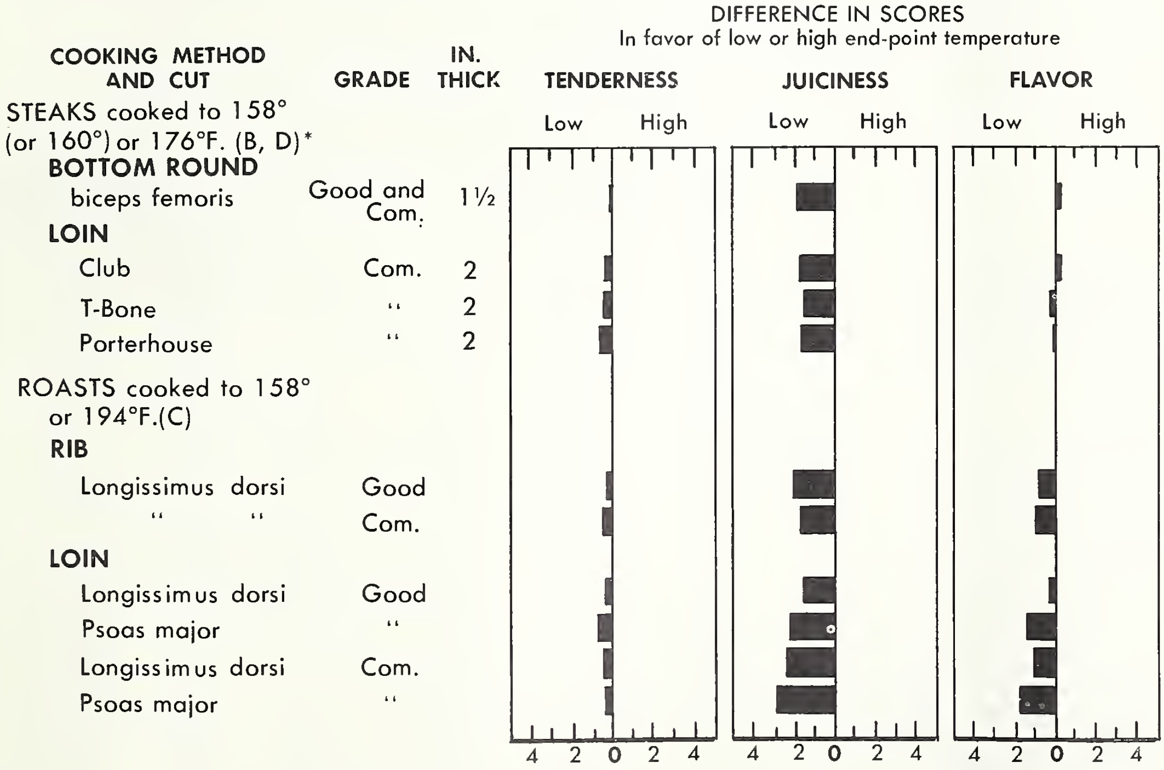
be no apparent difference in tendering of bottom round at the three temperatures, top round was slightly more tender at 185°. Differences in scores for juiciness showed that this quality decreased with an increase in internal temperature.

Broiled or roasted cuts.--When paired cuts of steer beef were cooked by dry heat to two internal temperatures, differences in average palatability scores again tended to favor the lower end-point temperatures (figure 5).

All steaks were more tender and juicy when cooked to the lower end-point temperature. Roasts from the loin and rib (station C) cooked to 158° F. were rated consistently more tender, juicy, and flavorful than those cooked to 194°. Except for bottom round (station B) and club steak (station D), which were considered slightly more desirable in flavor when broiled to 176° than to 158°, the steaks cooked to 158° or 160° were rated higher in flavor than well-done steaks (station D).

Roasted or braised cuts.--Direct comparisons of mean values and test differences of palatability scores for various muscle cuts from six steers of Good and Commercial grades roasted or braised to end-point temperatures of 158° or 194° F. at station C are given in table 3.

In tenderness, juiciness, and flavor all cuts roasted at 300° F. (muscles from rib and loin) were scored higher at an end point of 158° than at the highest end point; the differences were significant at the 5-percent level with one exception--tenderness of the longissimus dorsi of the loin. Data on the braised cuts (muscles from top and bottom round) showed no significant differences in tenderness between meat cooked to 158° and 194°. Juiciness scores were significantly higher in all cases for cuts braised to 158°. Flavor was scored significantly higher at this temperature only for the biceps femoris muscle. Juiciness and tenderness values determined by press fluid and shear force, respectively, likewise showed the cuts to be significantly more juicy but not significantly more tender when cooked to 158°.



*.Steaks were oven-broiled at 300° at Station D, and at 350° at Station B; thick cuts were roasted at 300° at Station C.

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FIGURE 5.--Comparison of different end-point temperatures of doneness for steer beef cooked by broiling and roasting.

TABLE 3.--Mean values and test differences of palatability scores for muscles from six steers of Good and Commercial grades cooked to 158° and 194° F. (station C)

Cooking method and cut	Internal temperature	Mean scores for--[1]		
		Tenderness	Juiciness	Flavor
Roasted at 300°:	°F.			
Rib, longissimus dorsi	158	7.0	6.4	7.1
	194	6.4*	4.1*	6.1*
Loin, longissimus dorsi	158	6.6	6.6	7.1
	194	6.2	4.4*	6.4*
Tenderloin, psoas major	158	8.7	7.4	7.8
	194	8.2*	4.7*	6.2*
Test difference[2]	--	0.5	0.7	0.5
Oven-braised at 300°:				
Top round, semimembranosus	158	6.1	4.8	6.5
	194	6.3	3.6*	5.9
Bottom round, biceps femoris	158	6.9	6.4	7.1
	194	6.7	4.0*	6.1*
Bottom round, semitendinosus	158	7.4	6.9	7.0
	194	7.1	4.4*	6.6
Test difference[2]	--	0.6	1.0	1.0

[1] * Significantly different at the 5-percent level.

[2] Any difference equal to or greater than the corresponding test difference is significant at the 5-percent level of Duncan's New Multiple Range Test.

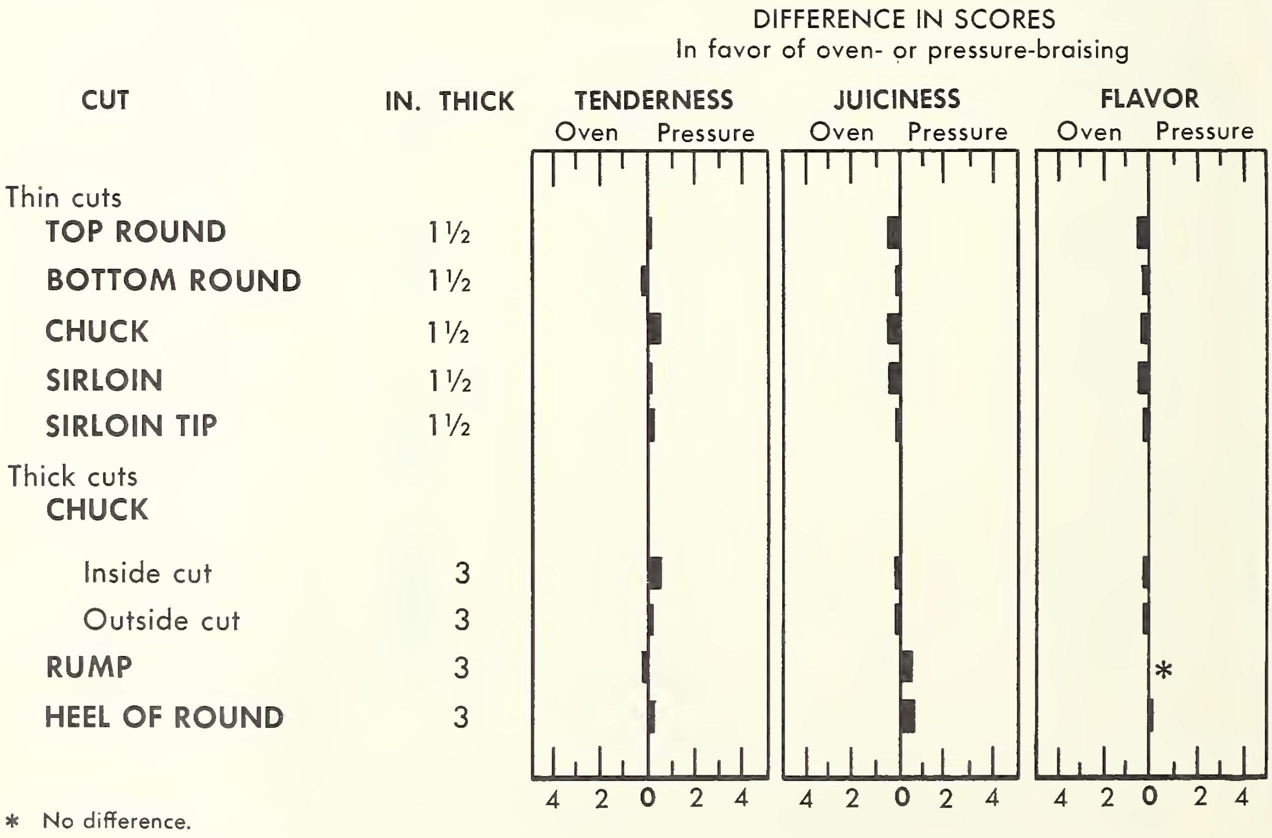

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FIGURE 6.--Comparison of oven-braising at 300° F. and pressure-braising Commercial grade steer beef at 10 pounds pressure to the same approximate end-point temperature (station D).

Oven- and Pressure-Braising Compared

When pressure-braised to an internal temperature of 176° F. beef was rated more tender but less juicy and flavorful than when oven-braised to the same temperature. When pressure-braised to 185° beef round was rated less tender, juicy, and flavorful than when oven-braised. Pressure-braising to 216° resulted in more palatable meat than oven-braising to 209°

Differences in palatability ratings resulting from oven- and pressure-braising cuts of Commercial steer beef to approximately the same end-point temperatures are found in figure 6 (station D).

Tenderness scores in almost all instances were higher when the cuts were pressure-braised at 10 pounds pressure than for paired cuts oven-braised to 176° F. though differences were not large enough for statistical significance. Tenderness by shear force was significantly better for pressure-braised chuck.

Oven-braising was significantly superior to pressure-braising for the following quality factors and cuts: Juiciness scores of top round, chuck, and sirloin steak; press fluid of sirloin steak; and flavor of chuck, sirloin steak, and sirloin tip.

When oven-braised at 300° top and bottom round cuts 1-1/2 inches thick cooked to 185° F. at station A were scored higher for tenderness, juiciness, and flavor than when pressure-braised at 5 or 10 pounds pressure, as shown graphically in figure 7.

When pressure-braised at 15 pounds pressure and oven-braised to 185° F., top round received comparable ratings for juiciness and flavor. Bottom round cuts pressure-braised at 15 pounds were scored higher in flavor than the oven-braised cuts, but, like the samples cooked at 5 and 10 pounds pressure, they were rated less tender than oven-braised meat at a comparable temperature of doneness.

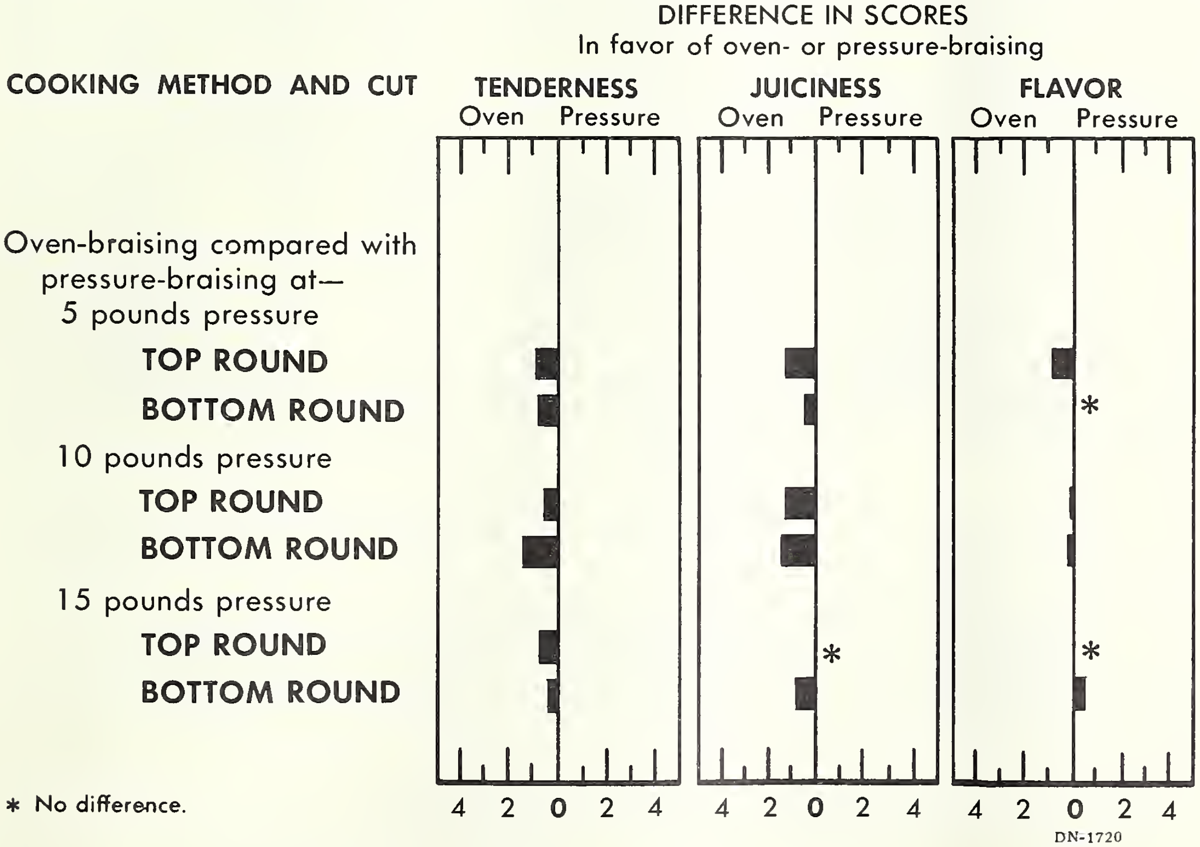

FIGURE 7.--Comparison of oven-braising at 300° F. and pressure-braising Commercial grade steer beef 1-1/2 inches thick to 185° at 5, 10, and 15 pounds pressure (station A).

Oven-braising and pressure-braising were also compared, using cuts of cow beef at station F. Chuck and rounds of cow beef were cooked to 209° F. by oven-braising and to 216° by pressure-braising at 10 pounds. Some of the meat used was unfrozen, some was frozen and thawed by two procedures--the cuts designated as "refrigerator-thawed" were completely defrosted at refrigerator temperature before cooking, whereas the "cooking-thawed" cuts were not thawed before cooking. Percentage differences in average palatability scores between cuts oven-braised to 209° and their paired cuts pressure-braised to 216° are shown in figure 8.

In general, the differences in scores favored the pressure-braised meat. When data for all cuts of cow beef were used in an analysis of variance, significant differences between the oven- and pressure-cooking were reported. For unfrozen or refrigerator-thawed cuts, tenderness scores were significantly higher for pressure-braised cuts. For cooking-thawed cuts, juiciness and flavor scores were significantly higher for pressure-braised cuts also.

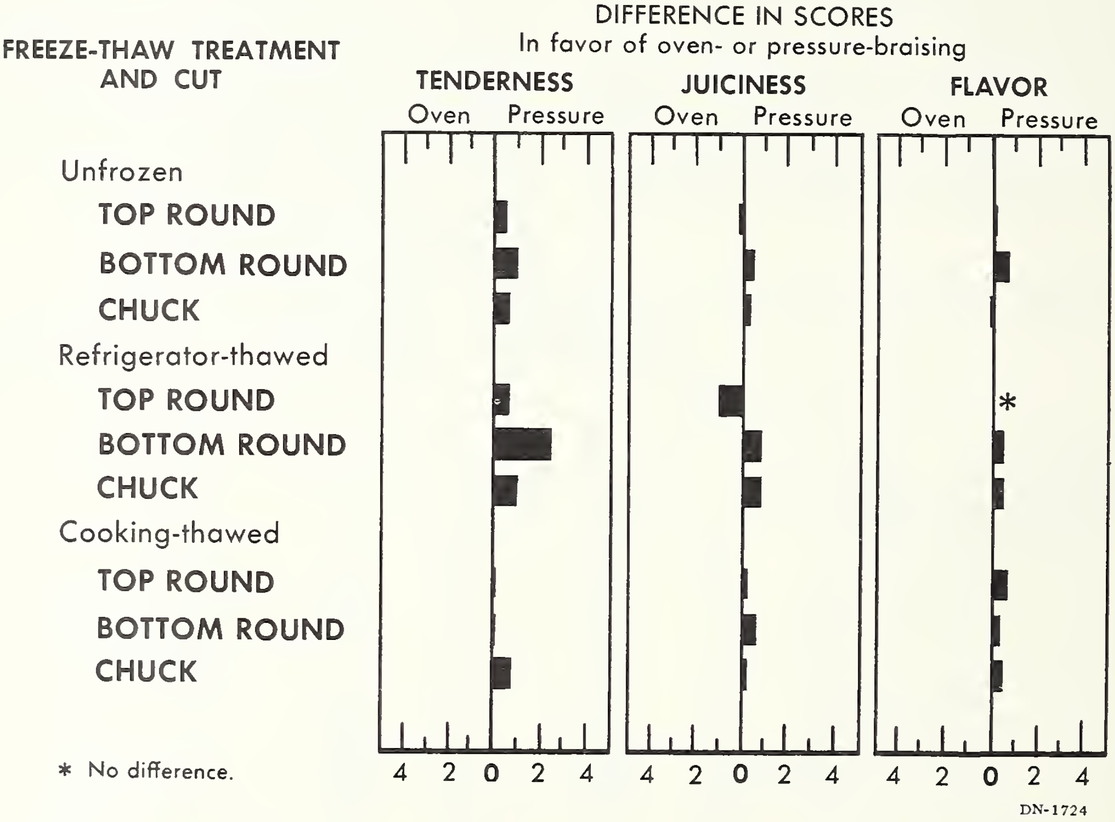

FIGURE 8.--Comparison of oven-braising to 209° F. and pressure-braising to 216° various cuts of cow beef after different freeze-thaw treatments (station F).

Tenderness of beef did not increase consistently with increased hydrolysis of collagen.

The change in collagen to gelatin by hydrolysis is believed to be related to tenderness of cooked meat. Three stations determined the collagen content of raw and cooked beef and were thus able to calculate the amount of hydrolysis that occurred under various cooking conditions and to study the relation of collagen hydrolysis to the tendering of beef.

In the interests of uniformity in this report, collagen nitrogen was calculated as a percentage of total nitrogen by use of the conversion factor of 6.25.

Collagen nitrogen was determined on 152 samples from high- and low-grade steer beef (station C). The total amount of collagen nitrogen found was very small--less than 6 percent of the total nitrogen in any cut and only 3 percent or less in 88 percent of the cuts. The distribution of the cuts from six muscles according to collagen nitrogen content is shown in figure 9. Psoas major had the largest percentage of cuts in the lowest range of collagen content, from 0 to 1.9 percent, and biceps femoris in the highest range, from 3.0 to 5.9 percent of collagen nitrogen.

The average collagen nitrogen according to muscle, grade, and age of animals (station C) is given in table 4. Analysis of variance showed that statistically significant differences at the 1-percent level were found among animals, among grades, and between ages in one grade as well as between animals of the same age and grade.

Station A also reported small amounts of collagen nitrogen in raw meat. The calculated collagen nitrogen for six raw samples of Commercial grade rounds that were used as controls in cooking tests ranged from 3.16 to 6.51 percent for top and bottom round, respectively.

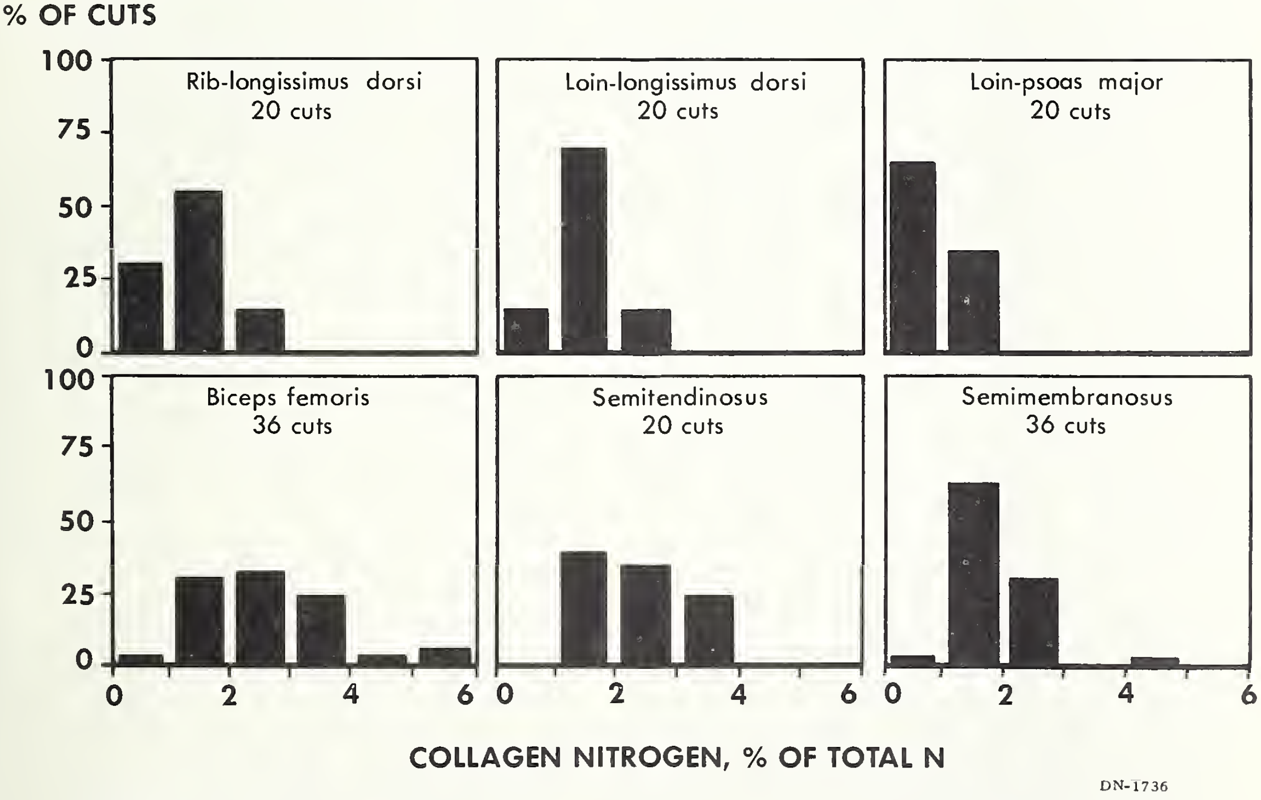

FIGURE 9.--Distribution of 152 cuts of steer beef representing six muscles according to content of collagen nitrogen (station C).

TABLE 4.--Average collagen nitrogen as a percentage of total nitrogen in raw cuts from steers differing in grade[1] and age (station C)

Cut and muscle	Collagen nitrogen as a percentage of total nitrogen			
	Prime, 17 months old	Good, 18 months old	Commercial	
			5-6 months old	42-48 months old
Top round:				
Semimembranosus	1.42	2.14	1.70	1.68
Bottom round:				
Semitendinosus	1.86	2.86	2.78	2.04
Biceps femoris	1.64	3.30	2.41	2.66
Rib:				
Longissimus dorsi	.88	1.88	1.90	1.27
Loin:				
Longissimus dorsi	.92	1.58	1.84	1.28
Psoas major	.88	1.10	1.47	.84

[1] Two animals in each age and grade group.

Station D determined the collagen nitrogen content by the centrifuge method of Hartley and Hall (13), in which collagen was hydrolyzed to gelatin from the homogenized samples after washing to remove the water-soluble proteins, and gelatin was isolated by centrifuging and filtering. Total nitrogen was determined on the homogenized meat and the collagen nitrogen was reported as a percentage of total nitrogen. By this method, collagen nitrogen was found to be appreciably higher than that reported by stations A and C. There was little variation among the different cuts in the amount of collagen nitrogen. Average values for the raw meat from nine animals were as follows: 9.4 percent for the semimembranosus muscle of the top round, 10.4 for the semitendinosus of the bottom round and for outside chuck, 11.2 for inside chuck, and 9.8 and 10.5 percent for the longissimus dorsi muscle of the rib and loin, respectively.

All three stations calculated the amount of hydrolysis of collagen during cooking by differences between the amounts found in the raw and in the cooked meat. At station C paired cuts were cooked to 158° and to 194° F., enabling a comparison of the amount of hydrolysis that occurred during the time required to reach the lower temperature as well as the hydrolysis taking place during continued cooking. The average percentage loss of collagen from six muscles during cooking to 158° and to 194° is shown in table 5.

An appreciable amount of collagen was hydrolyzed during cooking of meat to an internal temperature of 158° F. in all cuts by both dry- and moist-heat cookery. There seemed to be no relation between the proportion of collagen hydrolyzed and the cooking time needed to reach 158°. Longissimus dorsi of rib roasted the longest time, 284 minutes, lost the least of its collagen, 46 percent, whereas rib roasted 190 minutes lost 75 percent (table 38).

Differences in collagen content between cuts cooked to 158° F. and paired cuts cooked to 194° showed that hydrolysis continued with the longer cooking required to reach 194°. The percentage loss at 194°, however, was not related to the cooking time either in braising or in roasting. This fact is shown in table 5, together with changes in tenderness of the paired cuts cooked to the two temperatures. Negative values for pounds of shear force indicate an increase in tenderness.

Tenderness did not increase consistently with increased hydrolysis of collagen. Since most of the collagen hydrolysis had occurred by the time an internal temperature of 158° F. had been reached, cooking need not have been prolonged beyond that temperature to hydrolyze the collagen. That collagen hydrolysis by itself was not a major factor in the tendering of the meat was also shown by results reported by station A when comparing tenderness and collagen loss of beef rounds braised to 176°, 185°, or 199°.

TABLE 5.--Increase or decrease in collagen loss and tenderness of six cuts of beef cooked at 300° F. to an internal temperature of 194° as compared with paired cuts cooked to 158° (station C)

Cooking method, cut, and age of animal in months	Cuts	Cooking time to--		Collagen loss when cooked to--		Increase (+) or decrease (-) in values, 194° F. compared with 158° F.	
		158° F.	194° F.	158° F.	194° F.	Tenderness score	Shear force
Oven-braised:							
Top round, semimembranosus:	*Number*	*Minutes*	*Minutes*	*Percent*	*Percent*		*Pounds*
5 to 6	4	107	134	61	85	+0.1	+1.6
18 to 19	4	155	183	74	86	-.1	+.5
42 to 48	5	190	232	72	86	+.6	-4.2
Bottom round, semitendinosus:							
5 to 6	2	81	100	64	94	-.8	-4.4
18 to 19	1	95	140	61	90	-.7	+2.8
42 to 48	3	106	159	71	92	+.1	-.9
Bottom round, biceps femoris:							
5 to 6	4	84	116	86	89	+.2	+.7
18 to 19	4	127	148	68	85	-.5	-1.7
42 to 48	5	156	192	78	94	-.5	-4.8
Roasted:							
Rib, longissimus dorsi:							
5 to 6	2	190	250	75	88	-.3	+3.4
18 to 19	2	229	302	69	66	-.7	+5.7
42 to 48	3	284	404	46	85	-.7	-2.3
Loin, longissimus dorsi:							
5 to 6	2	162	252	93	86	+.2	-3.6
18 to 19	2	136	242	74	84	-.9	-3.7
42 to 48	3	179	290	73	91	-.2	-5.0
Loin, psoas major:							
5 to 6	2	145	250	64	81	-.6	-1.3
18 to 19	2	125	252	80	87	-.9	+.6
42 to 48	3	174	278	65	67	0	-2.3

Average values are shown in table 6. Only the bottom rounds showed consistently more hydrolysis on increased cooking. However, the taste panel detected no difference in the tenderness of the meat cooked to the three temperatures, although shear-force values decreased appreciably, indicating greater tenderness. No significant correlation was reported by station A between the amount of collagen in the cooked meat of top and bottom rounds and either shear-force values or panel scores for tenderness.

No consistent evidence that collagen hydrolysis contributed to tenderness is given in data for tenderness and collagen hydrolysis for cuts cooked to 176° F. and paired cuts cooked to 158° (station D) as shown in table 7. Only the rib roasted at 300° showed a perceptible increase in collagen loss that was accompanied by a decrease rather than an increase in tenderness. An apparent increase in collagen-nitrogen values during cooking may have been due to a number of factors, such as changes in the constitution and distribution of the nitrogen and changes in the physical structure of the protein during cooking.

Data from stations A and C show no correlation between collagen content and tenderness of cooked meat, although for raw meat a significant correlation was found between collagen content and tenderness scores of cooked meat at station C. This latter correlation was too low (coefficient of 0.374), however, to be useful in predicting the tenderness of cooked meat from the collagen content of the raw meat.

TABLE 6.--Average cooking time, collagen loss, and tenderness values for Commercial grade beef rounds braised to three temperatures (station A)

Cut and internal temperature (°F.)	Samples	Cooking time	Collagen loss	Tenderness	
				Score	Shear force
	Number	*Minutes*	*Percent*		*Pounds*
Top round:					
176°...........................	2	70	[1] 64	6.6	19.4
185°...........................	2	65	[1] 40	7.4	19.5
199°...........................	1	95	62	5.6	27.7
Bottom round:					
176°...........................	2	36	44	6.0	33.5
185°...........................	2	62	60	6.0	25.5
199°...........................	2	76	81	6.0	21.8

[1] Data available for one sample only.

TABLE 7.--Increase or decrease in collagen loss and tenderness values of six Commercial cuts from 30- to 36-month-old steers cooked to 176° F. as compared with paired cuts cooked to 158° (station D)

Cooking method and cut	Increase (+) or decrease (-) in values, 176° compared with 158°		
	Collagen loss	Tenderness	
		Score	Shear force
	Percent		*Pounds*
Roasted at 300°:			
Rib................................	+10	-0.3	+4.3
Oven-broiled at 300°:			
Club steak.........................	--	- .4	-2.3
T-bone.............................	+ 2	- .5	- .4
Porterhouse steak..................	+ 2	- .7	+2.6

TENDERNESS AS RELATED TO ELASTIN CONTENT

Definite conclusions cannot be drawn from this study as to the relations between elastin content and tenderness of cooked beef.

Elastin is a type of connective tissue that is resistant to hydrolysis, to mild acids or alkalis, and even to enzymes. Lack of tenderness in meats in which collagen has softened has been thought to be due to the presence of elastin.

The elastin content of aliquots of the slurry prepared for collagen analysis from six muscles of four steers varying in age and grade was determined at station C (table 8). The amounts of elastin found in any of the muscles were very small and because of unequal distribution, the sampling error was believed to be high. The range in average values of elastin nitrogen for the semitendinosus muscle from different animals was high. For example, a range of 2.08 noted in cooked cuts was larger than the total amount reported for any other muscle.

It was found, however, that the semitendinosus muscle contained appreciably larger quantities of elastin than any of the other muscles analyzed. If elastin in the amount found in the semitendinosus contributed appreciably to the toughness of cooked meat, then shear-force values for semitendinosus, with fat and collagen content similar to that of semimembranosus, should be higher than for the other muscle. But as shown in table 8, average shear-force values were similar for both muscles, although elastin was present in semitendinosus in 10 times the quantity found in semimembranosus.

The elastin nitrogen in semitendinosus from steers 5 to 6 months old was found to be appreciably higher than that in semitendinosus from animals of 42 to 48 months --3.16 percent and 1.47 percent, respectively--but the shear-force value was lower --21 pounds for cooked cuts from young animals and 24 pounds for cuts from older animals.

The roasted cuts of the rib and loin had slightly lower average elastin and collagen contents than the braised cuts of top and bottom round, but the shear-force values were not consistently lower.

Owing to the high experimental error in determining the elastin content, conclusions drawn as to the relation between elastin content and tenderness of cooked beef can be only tentative.

TABLE 8.--Average values for fat, collagen nitrogen, elastin nitrogen, and shear force for six muscles from four steers (station C)

Cooking method and cut	Fat content, raw, dry basis	Cooked beef		
		Collagen nitrogen as percentage of total nitrogen	Elastin nitrogen as percentage of total nitrogen	Shear force
Braised:[1]				
Top round:	*Percent*	*Percent*	*Percent*	*Pounds*
Semimembranosus.........	9.4	0.36	0.16	22.2
Bottom round:				
Semitendinosus..........	14.3	.39	1.76	21.8
Biceps femoris..........	11.2	.45	.21	17.4
Roasted:[1]				
Rib:				
Longissimus dorsi.......	11.4	.28	.10	18.8
Loin:				
Longissimus dorsi.......	12.4	.19	.10	18.0
Psoas major.............	19.6	.27	.10	13.1

[1] Average of cuts cooked to 158° or 194° F.

Intramuscular fat content was a factor contributing to tenderness of beef.

The influence of intramuscular fat in a cut of beef on its tenderness may be evaluated from data at station C. By plotting the samples in accordance with shear-force values of various cuts of beef cooked by roasting or by braising and their respective fat contents, raw and cooked, it is shown that there was a trend for tenderness to increase with an increase in the intramuscular fat content. This relation may be seen in figure 10.

The cut showing the greatest resistance to shear force (least tender meat) had the lowest fat content, while the cut showing the least resistance contained the highest fat content (table 8). The highly significant correlation coefficient of -0.76 between fat content of raw beef and tenderness by shear force when cooked indicates a fairly close relation between these two factors (station C, table 9). The correlation coefficient of -0.83 was obtained between fat content when cooked and tenderness of cooked meat by shear force. Station C also reported a significant correlation of +0.46 for fat content and tenderness by panel scores. As the fat content of beef increased, panel scores generally were higher and indicated an increase in tenderness.

Similar relations were observed by data from stations C and D. Correlation coefficients between tenderness of roasted and braised beef and fat content of raw and cooked beef were statistically significant.

All cuts at station F were braised to internal temperatures of 209° or 216° F., whereas at stations C and D cuts were roasted and braised to lower temperatures. Most of the cuts at station F were very tender, requiring about 15 pounds of shear force, so that the relation between tenderness by shear force and fat content of the raw meat was not significant, as was shown by a correlation of -0.40. A somewhat higher though not significant correlation of -0.64 was obtained for the cooked cuts.

Results from station G are not comparable with those of stations C and D, because station G determined the fat content without trimming all the exterior fat. Coefficients of correlation between shear-force values and fat content in this case were extremely low, -0.09 and -0.16 for raw and cooked beef, respectively.

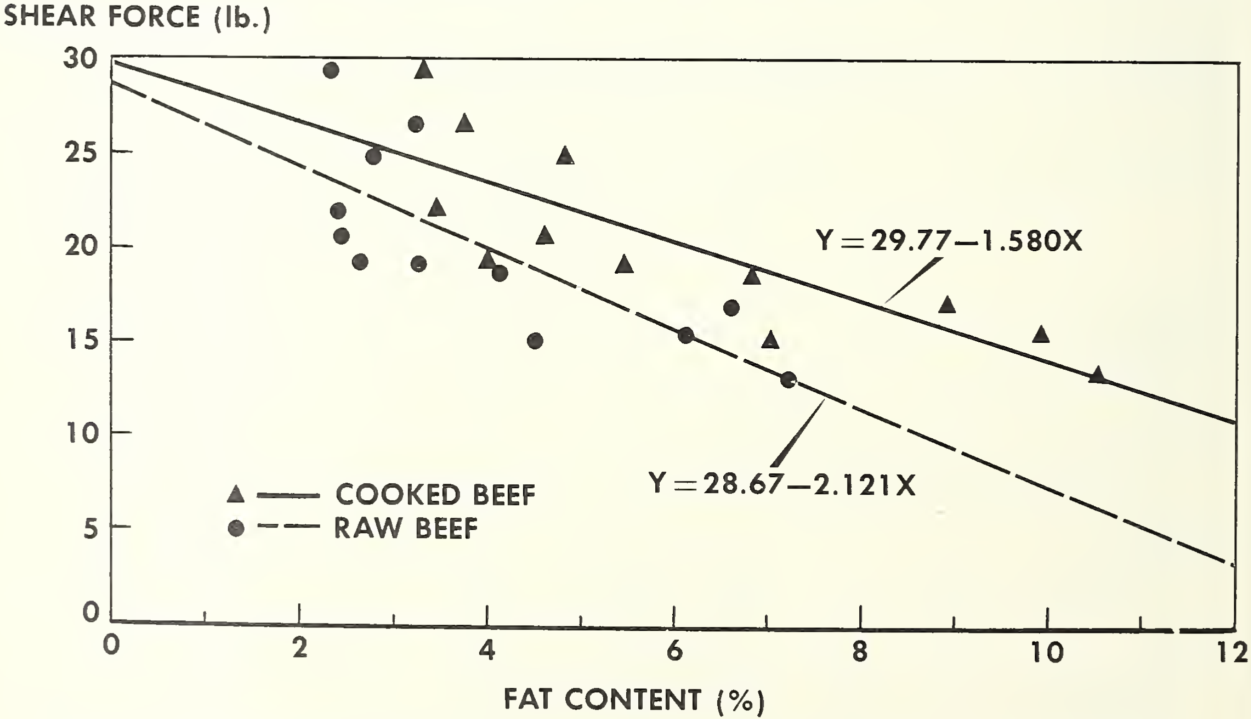

FIGURE 10.--Relation between shear-force values of cooked beef and fat content of raw and cooked beef (station C).

TABLE 9.--Coefficients of correlation between tenderness of cooked beef and fat content of raw and cooked beef

Cooking method and station code	Samples[1]	Fat content, moist basis	Shear-force value	Coefficient of correlation[2]	Equation for estimating shear force (Y) from fat content (X)
	Number	*Percent*	*Pounds*		
Raw..................................	12	4.0	--	-0.76**	Y= 28.67-2.121X
Roasted or braised to 158° or to 194° F. (C)........................	12	6.0	20.2	-.83**	Y= 29.77-1.580X
Raw..................................	7	4.0	--	-.73	Y= 23.88-1.626X
Roasted or braised to 176° F. (D)....	7	7.9	17.4	-.78*	Y= 23.10-0.717X
Raw..................................	9	4.2	--	-.40	Y= 18.01-0.693X
Braised well done to 209° or 216° F. (F)................................	9	6.1	15.1	-.64	Y= 21.74-1.086X
Raw..................................	20	18.7	--	-.09	Y= 22.79-0.054X
Roasted to 176° or braised to 199° or 208° F. (G)....................	20	22.5	21.8	-.16	Y= 23.67-0.084X

[1] Samples for fat analyses from stations C, D, and F were trimmed of fat; those from station G were only partially trimmed.

[2] * Significantly different from zero at the 5-percent level; ** significantly different from zero at the 1-percent level.

Loin of Utility grade steer beef cooked by both moist and dry heat was shown to be the least tender of all cuts studied, although it contained more intramuscular fat than chuck and rounds (table 35). Braised rib and loin of Good grade were less tender than chuck and bottom round of Utility grade containing relatively little fat. Rib and loin of Good grade, on the other hand, were more tender than other cuts cooked by dry heat, but they also contained more fat. These results were no doubt influenced by the fact that cuts were cooked to different end points; i.e., to 199° F. for chuck, ribs, and loin and to 208° for rounds. Bottom round could have become more tender from increased cooking.

It is expected that inherent fat characteristics of different animals would influence tenderness when cooking conditions are standardized. Comparisons of values for roasted rib cuts from a number of steers at stations D and C are shown in tables 10 and 11, respectively. Differences in tenderness and fat content of cuts from different animals were apparent not only at station C where ages of animals and grades of beef varied widely, but also at station D where cuts were of one grade and all animals were approximately the same age. The data from both stations indicate that intramuscular fat content of meat from individual animals is a contributing factor to tenderness of beef.

TABLE 10.--Shear-force values and intramuscular fat content of Commercial grade ribs roasted to 176° F. from steers in the same age group (station D)

Animal No.	Age of animal	Shear-force value	Fat content, moist basis	
			Raw	Cooked
	Months	*Pounds*	*Percent*	*Percent*
1	30	25.0	3.2	9.8
2	30	13.1	4.3	7.6
3	36	19.2	4.1	10.1
4	36	17.3	3.8	8.3
5	36	12.8	6.4	10.0
6	36	10.9	8.3	15.0
7	36 to 48	14.5	2.2	7.8
8	36 to 48	12.4	2.7	6.9
9	36 to 48	11.3	4.5	7.4

TABLE 11.--Shear-force values and fat content of ribs roasted to 158° F. from steers differing in age and grade (station C)[1]

Grade	Age of animal	Shear-force value	Fat content, dry basis[1]	
			Raw	Cooked
	Months	*Pounds*	*Percent*	*Percent*
Good	6	29.7	13.8	11.4
Commercial	6	22.6	4.8	6.0
Prime	17	18.8	16.2	19.7
Prime	18-1/2	11.6	25.2	27.1
Good	18	22.2	14.6	10.3
Commercial	19	27.0	10.6	9.7
Commercial	42 to 48	24.5	16.6	19.0
Commercial	42 to 48	20.4	13.6	12.1

[1] Samples for fat analyses were partially trimmed.

JUICINESS AS RELATED TO FAT CONTENT, COOKING LOSSES, AND MOISTURE CONTENT

Internal temperatures to which meat is cooked and resultant cooking losses exerted more influence on juiciness than did the fat content of the beef.

It has already been shown that the presence of intramuscular fat may be a factor contributing to meat tenderness. Fat has also been considered a factor in enhancing juiciness. Coefficients of correlation presented in table 12 are indicative of relations, if any, existing between (a) fat content of raw meat and juiciness scores of cooked meat, (b) total cooking losses and juiciness scores, and (c) total cooking losses and fat content, raw.

The correlation between fat content and juiciness scores was not significant. Significant inverse correlations were found, however, between juiciness scores and total cooking losses of roasted loin and rib cuts and braised round cuts. Total cooking losses for broiled and braised loin steaks but not for roasted loin and rib cuts or braised round cuts were significantly correlated with fat content of raw meat.

That an increase in cooking loss accounts for part of the decrease in juiciness is corroborated by the decrease in press fluid when cooking losses increase. Whether the cuts were braised or roasted, press fluid decreased as cooking losses increased. This relation is shown in figures 11 and 12.

The relative importance of the fat content and press fluid in the juiciness of meat may be shown by comparing the fat and press fluid values for paired cuts cooked to different temperatures. If little or no loss in intramuscular fat is incurred as the internal temperature of the meat is increased but juiciness decreases, obviously the factor having the greater influence on juiciness is the moisture in the muscle fiber. Table 13 shows how average values for three muscles from different animals roasted to 158° F. compare with values for paired cuts roasted to 194°.

There was usually a slight increase rather than a loss in the percentage of extractable fat, after cooking had been continued from an internal temperature of 158° F. to one of 194°. At the same time, juiciness scores and percentage of press fluid along with percentage of moisture were appreciably lowered.

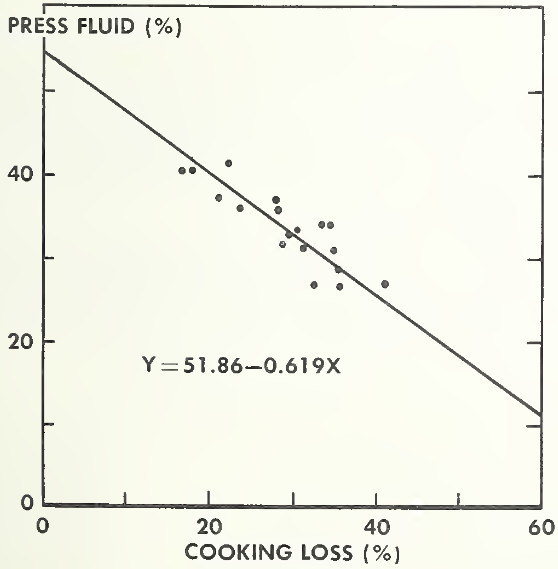

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FIGURE 11.--Relation between press fluid and cooking losses from braised round cuts of steer beef (station C).

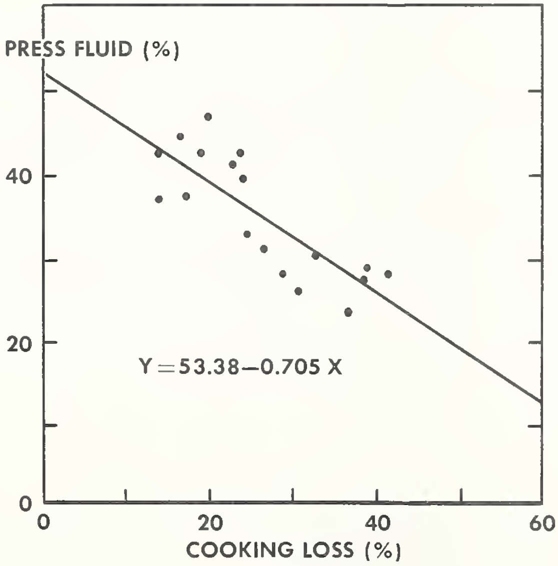

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FIGURE 12.--Relation between press fluid and cooking losses from roasted loin and rib cuts of steer beef (station C).

TABLE 12.--Coefficients of correlation between various factors related to juiciness for beef cuts of Good grade and below cooked by different methods

Station and factors related	Observations	Coefficient of correlation[1]
Station C		
Fat content (raw) and juiciness score:	*Number*	
Roasted loin and rib cuts	48	+0.11
Braised round cuts	46	+.12
Roasted and braised cuts	94	+.16
Total cooking loss and juiciness score:		
Roasted loin and rib cuts	46	-.74**
Braised round cuts	46	-.84**
Roasted and braised cuts	92	-.78**
Total cooking loss and fat content (raw):		
Roasted loin and rib cuts	46	+.25
Braised round cuts	46	-.02
Station D		
Total cooking loss and fat content (raw):		
Broiled loin steaks	9	-.36
Braised loin steaks	6	-.82*
Broiled and braised loin steaks	15	-.74**

[1] * Significantly different from zero at the 5-percent level; ** significantly different from zero at the 1-percent level.

Press-fluid values and juiciness scores also were found to decrease when cuts were cooked to 176° F. compared with 158° (station D). Average values for loin steaks from Commercial grade steers are shown in table 14.

At two stations where no press-fluid determinations were made, panel scores for paired cuts cooked to different end points showed a consistent decrease in juiciness with an increase in internal temperature. Biceps femoris scored 8.2 and 6.3 in juiciness when roasted to 160° F. and 176°, respectively (station B). Juiciness scores for bottom round braised to 176°, 185°, or 199° F. were 6.5, 5.9, and 5.2, respectively (station A).

It is concluded that fat contributes to the juiciness of meat, but that cooking to a low internal temperature and resultant small cooking losses of juices might be expected to have a far greater influence.

TABLE 13.--Increase or decrease in fat content, juiciness scores, press-fluid values, and moisture content of steer beef roasted to an internal temperature of 194° F. as compared with paired cuts roasted to 158° (station C)[1]

Animal No.	End-point temperature	Fat content, dry basis	Juiciness score	Press-fluid value	Moisture content
	°F.	*Percent*		*Percent*	*Percent*
1	158°	16.8	7.6	46.7	64.6
	194°	17.3	5.3	28.4	57.8
	Difference	+.5	-2.3	-18.3	-6.8
2	158°	22.1	8.2	43.5	64.2
	194°	25.5	4.6	29.8	58.1
	Difference	+3.4	-3.6	-13.7	-6.1
3	158°	8.2	6.5	37.7	72.7
	194°	7.4	5.6	32.2	70.1
	Difference	-.8	-.9	-5.5	-2.6
4	158°	14.1	7.0	44.0	69.9
	194°	18.9	3.8	27.9	64.6
	Difference	+4.8	-3.2	-16.1	-5.3
5	158°	12.0	6.9	43.2	64.7
	194°	11.8	4.3	26.9	60.3
	Difference	-.2	-2.6	-16.3	-4.4
6	158°	27.7	7.6	40.4	60.9
	194°	29.4	4.0	30.8	57.0
	Difference	+1.7	-3.6	-9.6	-3.9
7	158°	13.4	6.2	39.8	61.4
	194°	16.0	4.2	30.3	62.1
	Difference	+2.6	-2.0	-9.5	+.7
8	158°	20.4	6.6	29.8	59.4
	194°	20.5	3.8	26.1	60.2
	Difference	+.1	-2.8	-13.7	+.8

---

[1] Paired muscles from 8 steers, longissimus dorsi of the rib and loin and the psoas major of the loin; values are averages of all samples.

TABLE 14.--Increase or decrease in cooking loss, juiciness score, and press-fluid value of Commercial grade loin steaks resulting from increasing the end point of broiling from 158° to 176° F. (station D)

Cut and end-point temperature (°F.)	Cooking loss	Juiciness score	Press-fluid value
	Percent		*Percent*
Club:			
158°	19.0	8.5	38.0
176°	26.9	6.8	29.2
Difference	+7.9	-1.7	-8.8
T-bone:			
158°	21.4	8.3	38.0
176°	29.2	6.8	28.8
Difference	+7.8	-1.5	-9.2
Porterhouse:			
158°	22.6	7.9	35.6
176°	34.3	6.3	22.4
Difference	+11.7	-1.6	-13.2

TABLE 15.--Fat content and flavor scores for loin and rib cuts roasted to an end-point temperature of 158° F. (station C)

Cut and animal No.	Grade	Age of animal	Fat content, dry basis		Flavor score
			Raw	Cooked	
		Months	*Percent*	*Percent*	
Loin:					
1	Commercial	5 to 6	5.6	9.1	7.2
2	Commercial	19	9.4	9.4	7.0
3	Good	6	9.8	14.3	5.5
4	Commercial	42 to 48	10.4	14.2	7.2
5	Commercial	42 to 48	13.9	18.3	7.2
6	Good	18	14.8	10.1	8.0
7	Prime	17	20.4	22.9	10.0
8	Prime	18.5	23.4	29.2	8.0
Rib:					
1	Commercial	5 to 6	4.8	6.0	7.0
2	Commercial	19	10.6	9.7	6.3
3	Good	6	13.8	11.4	6.2
4	Commercial	42 to 48	13.6	12.1	7.5
5	Good	18	14.6	10.3	8.5
6	Commercial	42 to 48	16.6	19.0	6.8
7	Prime	17	16.2	19.7	10.0
8	Prime	18.5	25.2	27.1	8.2

FLAVOR AS RELATED TO FAT CONTENT

Quantity of fat is not necessarily an indication of meat flavor.

Fat interspersed in muscle fibers has been considered desirable for flavor. Data from station C showed considerable variation in fat content of loin and rib cuts among eight steers of various grades.

When flavor scores of the muscles cooked under the same standardized conditions were compared, it appeared that the score tended to be slightly higher as the fat content was higher. This is suggested by values for the longissimus dorsi muscle of loin and rib roasted to 158° F. given in table 15. On the other hand, no increase in flavor score accompanied an increase in fat content among nine Commercial grade rib cuts roasted to 176° at station D, as found in the values in table 16.

Whereas the flavor of beef from one animal might be enhanced by an increase in fat content, the fat of cuts from different animals might vary in character, so that flavor differences found might be due to the quality as well as to the quantity of fat.

TABLE 16.--Fat content and flavor scores of Commercial grade rib cuts roasted to 176° F. (station D)

Cut No.	Fat content, moist basis		Flavor score
	Raw	Cooked	
	Percent	*Percent*	
1...........	2.2	7.8	8.0
2...........	2.7	6.9	8.3
3...........	3.2	9.8	8.0
4...........	3.8	8.3	8.1
5...........	4.1	10.1	8.3
6...........	4.3	7.6	8.3
7...........	4.5	7.4	8.5
8...........	6.4	10.0	7.9
9...........	8.3	15.0	8.4

EFFECT OF COLD STORAGE HOLDING ON PALATABILITY

There was no evident advantage in holding Commercial grade cow beef longer than 7 days in cold storage. Increasing the length of storage at 32° to 34° F. from 7 to 21 days did not increase the tenderness of steaks and resulted in lower scores for flavor and juiciness.

Station E investigated the effect of holding cuts from dairy cow beef of Commercial grade in cold storage. Palatability values for semimembranosus, semitendinosus, and biceps femoris muscles, averaged for two cooking methods for all cuts, are shown in table 17 for the various storage periods.

TABLE 17.--Average panel scores for palatability of cow beef cooked after holding for 7 to 21 days at 32° to 34° F. (station E)[1]

Days of holding	Tenderness		Juiciness score	Flavor score
	Shear force	Score		
	Pounds			
7..........	12.0	4.2	6.0	6.5
9..........	11.7	4.2	5.6	6.1
11..........	12.3	4.2	5.6	6.3
14..........	11.3	4.2	4.9	5.8
21..........	10.9	4.5	5.1	4.6

[1] Average of scores for all cuts oven-broiled to 160° and braised to 176° F.

EFFECT OF FREEZE-THAW METHODS ON PALATABILITY

In tenderness, juiciness, and flavor, frozen meat cooked without thawing or after thawing in the refrigerator was little different from unfrozen meat when range-braised to 209° or pressure-braised to 216° F.

Station F investigated the effects of freezing on the palatability of beef. Bottom round, top round, and chuck cuts from Utility, Commercial, and Cutter grade cows were paired for different cooking tests. Cuts from some of the animals were not frozen, while others were frozen and cooked either immediately after being taken from the freezer or after being thawed in a refrigerator. Values for tenderness, juiciness, and flavor, averaged for all grades, cuts, and cooking methods, that resulted from the different freezing-thawing procedures are shown in table 18.

Analysis of variance showed no significant differences in palatability due to freezing of the beef in this study. The method of thawing had little effect on the tenderness, juiciness, and flavor of cooked beef.

TABLE 18.--Tenderness, juiciness, and flavor values for cow beef when cooked unfrozen, frozen, or thawed (station F)[1]

Treatment	Tenderness		Juiciness		Flavor score
	Shear force	Score	Press fluid	Score	
	Pounds		*Percent*		
Unfrozen....................	11.6	6.3	45.6	5.1	6.3
Frozen, refrigerator-thawed..	13.8	6.6	--	5.6	6.2
Frozen, cooking-thawed.......	12.3	6.8	41.9	5.5	6.4

[1] Average of range-braised at 209° and pressure-braised to 216° F.

EFFECT OF MECHANICAL AND CHEMICAL PRETREATMENT OF CUTS ON PALATABILITY

The application of enzymes to the surface of the meat increased its tenderness at a possible sacrifice of juiciness and flavor. Pounding the meat increased its tenderness slightly. Vinegar as a tenderizer was undesirable.

Station A studied the effect of various mechanical and chemical treatments on cuts of round from Commercial grade steer beef, after which the cuts were braised to an internal temperature of 185° F. Each pretreatment was evaluated by comparison with an untreated reference standard. The difference in average panel scores between the untreated and the treated cuts shows the effect of pretreatment on tenderness, juiciness, and flavor of the beef (figure 13).

As shown in figure 13, cuts treated with commercially prepared enzyme or with papain mixture were rated more tender by the panel than standard-braised cuts. Shear-force values showed that enzyme-treated cuts required on the average 11 pounds less force to shear than the untreated ones. Pounding did not produce any tendering effect as indicated by percentage differences in panel scores, but the shear-force value for meat after this treatment was 20 pounds as compared with 25 pounds for the untreated cuts. Scoring had no appreciable effect on either tenderness scores or shear-force values. Soaking in vinegar for 48 hours in a refrigerator or braising in vinegar failed to increase tenderness either as shown by their difference in panel scores or as measured by shear-force values. The latter averaged 27 pounds for treated cuts and 24 pounds for the untreated.

Juiciness and flavor were rated as high or higher by panel scores for untreated cuts, than for treated cuts.

These results suggest that, at least for beef braised well done, vinegar is ineffective as a tenderizer, that enzyme applications to the surface of the meat increase tenderness at a possible sacrifice of juiciness and flavor, and that pounding the meat may increase tenderness slightly.

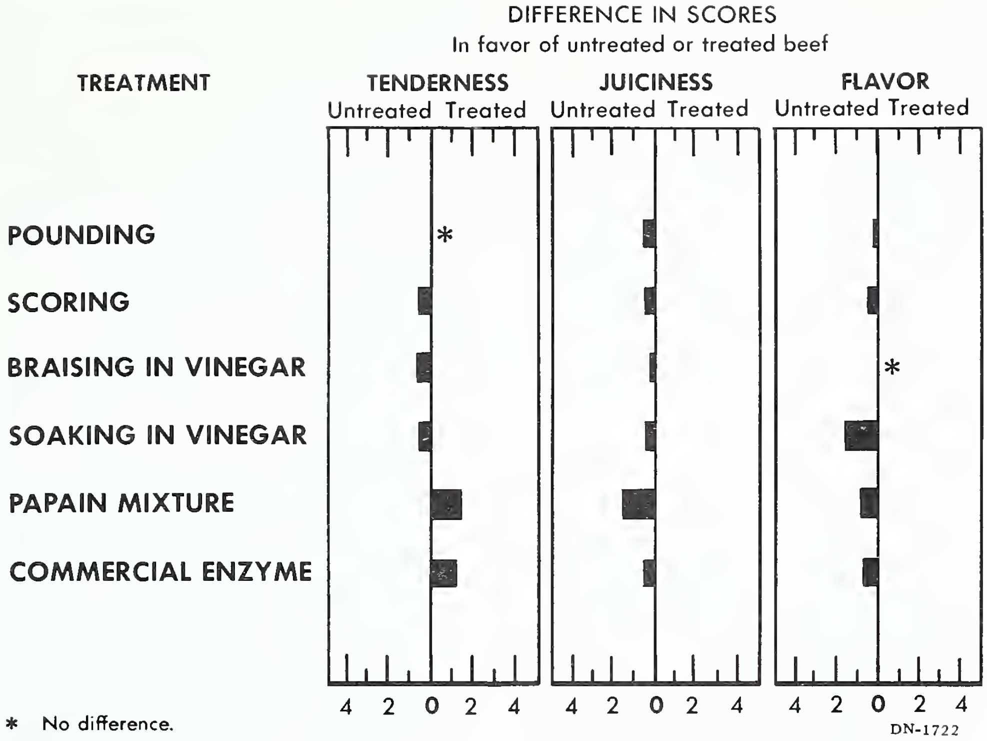

FIGURE 13.--Effect of various pretreatments on the palatability of braised beef round from Commercial grade of steer beef (station A).

VITAMIN RETENTION IN THE COOKING OF BEEF OF GOOD GRADE AND BELOW

Differences in retention of vitamins between dry- and moist-heat methods of cooking beef were influenced by inter-relations of method of cooking, thickness of cut, muscle, time, temperature, and drippings loss. Retention of thiamine was consistently higher, but retention of riboflavin was consistently lower in oven-braised cuts than in pressure-braised cuts.

Stations B, F, and G studied the retention of thiamine and riboflavin in beef during cooking tests. In addition, station G also studied the retention of pantothenic acid and niacin.

Methods of assay used by the different stations were as follows: Modifications of thiochrome analysis for thiamine were used by all three stations; fluorometric method for riboflavin by stations B and F; and microbiological assay for riboflavin, pantothenic acid, and niacin by station G (table 29). Assays of vitamins were made on both raw and cooked samples of the various cuts of meat and results were reported as the percentage retentions in the cooked meat.

Assays on raw cuts showed considerable variation in their vitamin content, not only among animals but also among cuts of the same animal. For the cuts from animals used by the various stations, the vitamin content per 100 gm., on a dry fat-free basis, ranged from 0.19 to 1.20 mg. for thiamine, from 0.39 to 2.10 mg. for riboflavin, from 0.73 to 2.19 mg. for pantothenic acid, and from 18 to 26 mg. for niacin (tables 41 and 42).

Since all these vitamins are water soluble and vary in their stability to heat, it follows that the proportion retained in the cooked meat will depend upon the conditions imposed during cooking. In addition to the cooking time and temperature, size and shape of the cut and the amount of water used in cooking are factors that would be expected to affect the retention of vitamins under ordinary household methods of cooking.

Thin cuts (3/4-inch thick) from the top and bottom round, chuck, and loin were broiled from 34 to 37 minutes and their paired cuts were braised for 45 minutes with 1 cup of water added (station G). The average retention of thiamine, riboflavin, pantothenic acid, and niacin in these cuts is shown in table 19.

Retention of the vitamins in the meat averaged higher by broiling for all cuts except chuck. That a portion of the vitamin loss during braising was due to their solution into the cooking water is shown by higher retention figures for meat with broth than those for meat only. No attempt was made to recover drip losses during broiling. Values for braised meat with broth were also higher than for broiled meat only. Vitamin retention in meat with broth was higher for riboflavin than for thiamine, pantothenic acid, and niacin.

For meat only, retention of vitamins in the thin cuts was found to be highest in broiled cuts of top and bottom round. For all cuts except chuck, the percentage retention for all vitamins in the meat tended to be similar within each method of cooking. Braised meat and meat with broth retained more thiamine, pantothenic acid, and niacin in chuck than in other cuts, whereas broiled chuck cuts had the lowest retention values. Low values for broiled chuck cannot be explained by cooking losses, since the average shrinkage of 42 percent in broiling chuck was similar to that for other broiled cuts--top round 46 percent, bottom round 41 percent, and loin 39 percent.

In cuts 2-1/2-inches thick (table 20), retention of thiamine, riboflavin, pantothenic acid, and niacin showed the same trend as in the thin cuts--averages for five cuts indicated a higher percentage retention in the oven-roasted than in the range-braised meat, but less than in the braised meat plus broth (station G). Retention of pantothenic acid was similar for roasted meat and range-braised meat and broth. When broth was included, thiamine was more noticeably affected by both braising and roasting than were the other nutrients. The thick cuts, in general, retained slightly more of the B-vitamins studied than did the thin cuts.

A considerably longer time was required for roasting than for braising corresponding cuts. Roasted cuts on an average were cooked for 223 minutes at 302° F. and braised cuts, for 77 minutes at 212°. Apparently, cooking time made little difference in the amount of thiamine retained in the meat, as retention values were higher in three out of five roasted cuts which required considerably longer to cook than the braised cuts. In thiamine retention, top and bottom round and chuck had higher values when roasted; loin and rib cuts had higher values when braised.

The actual internal temperatures to which the meat is cooked must be considered as well as the time of cooking, however, when comparing braised with roasted cuts. Braising was continued until the internal temperature reached 199° F. in rib, loin, and chuck, and 208° in top and bottom rounds, whereas roasted cuts were cooked to 176° only. Not only was the braised meat subjected to internal temperatures ranging from 23° to 32° higher than were the roasts, but the broth was kept near 212° during the entire cooking period. Consequently, opportunities for solubility losses of nutrients were greater during braising and, in addition, the higher end-point temperatures may have favored an accelerated rate of destruction over that occurring during roasting. Obviously other factors besides cooking time must have been in operation to influence the thiamine retention.

Station B made thiamine and riboflavin assays on three cuts of steer beef that were cooked to an internal temperature of 176° F. by various dry- and moist-heat methods. The average cooking time and value for retention of thiamine and riboflavin according to cut, thickness, and cooking method are shown in table 21. Percentage differences in retention of thiamine and riboflavin in the cuts after cooking by the two methods are shown in figure 14.

Average retention of both vitamins tended to be somewhat better in thick than in thin cuts of meat in both methods of cooking. Lowest thiamine retention (47 percent) of cuts cooked by dry heat was observed in thin cuts of biceps femoris (broiled), which were cooked the shortest length of time (92 minutes), while the thick cuts of semitendinosus (roasted), which were cooked 29 minutes longer, retained 77 percent thiamine.

A graphic comparison of differences in the retention of thiamine after oven-braising and roasting top and bottom round, figure 14, showed braising to be favored for thin cuts and roasting for thick cuts. In the retention of riboflavin, dry-heat methods were favored for both thin and thick cuts. When the comparison was between range-braising and broiling, differences in the retention of thiamine and riboflavin for bottom round favored moist-heat methods.

Shrinkage data showed 40 percent loss in thin cuts of biceps femoris and 32 percent in thick cuts of semitendinosus, which may help to explain the greater loss of thiamine in the

TABLE 19.--Average retention of thiamine, riboflavin, pantothenic acid, and niacin in thin cuts of steer beef[1] as affected by braising and broiling (station G)

Cut	Range-braised 45 minutes		Broiled 34-37 minutes, meat only	Increase (+) or decrease (-) in values for broiled as compared with braised meat[2]
	Meat and broth	Meat only		
	Thiamine			
	Percent	*Percent*	*Percent*	*Percent*
Top round	56	36	64	+28
Bottom round	64	41	61	+20
Chuck	71	52	29	-23
Loin	58	31	58	+27
Average	62	47	53	--
	Riboflavin			
Top round	108	54	69	+15
Bottom round	95	55	65	+10
Chuck	89	51	46	- 5
Loin	88	54	59	+ 5
Average	95	54	60	--
	Pantothenic acid			
Top round	66	40	48	+ 8
Bottom round	57	34	50	+16
Chuck	84	58	32	-26
Loin	62	35	46	+11
Average	67	42	44	--
	Niacin			
Top round	95	49	71	+22
Bottom round	88	45	78	+33
Chuck	96	57	33	-24
Loin	76	41	68	+27
Average	89	48	62	--

[1] Average values of cuts from one steer of Good grade.
[2] Meat only.

TABLE 20.--Average retention of thiamine, riboflavin, pantothenic acid, and niacin in thick cuts of beef[1] as affected by range-braising and roasting (station G)

Cut	Range-braised at 212° F.		Roasted at 302° F.	Increase (+) or decrease (-) in values for roasted as compared with braised meat[2]
	Meat and broth	Meat only	Meat only	
	Thiamine			
	Percent	*Percent*	*Percent*	*Percent*
Top round..............	54	40	46	+6
Bottom round...........	56	38	52	+14
Chuck..................	62	45	48	+3
Loin...................	61	46	38	-8
Rib....................	66	45	41	-4
Average..............	59	43	45	--
	Riboflavin			
Top round..............	91	58	70	+12
Bottom round...........	90	56	67	+11
Chuck..................	95	62	70	+8
Loin...................	96	71	76	+5
Rib....................	93	62	69	+7
Average..............	93	62	70	--
	Pantothenic acid			
Top round..............	66	37	70	+33
Bottom round...........	58	34	65	+31
Chuck..................	61	44	64	+20
Loin...................	78	52	71	+19
Rib....................	72	51	66	+15
Average..............	67	44	67	--
	Niacin			
Top round..............	91	54	78	+24
Bottom round...........	94	54	74	+20
Chuck..................	91	55	75	+20
Loin...................	96	59	66	+7
Rib....................	89	55	77	+22
Average..............	92	55	74	--

[1] Average values of cuts 2-1/2 inches thick from one Good and one Utility grade animal.
[2] Meat only.

TABLE 21. --Average cooking time and retention of thiamine and riboflavin in paired cuts of top and bottom rounds of beef cooked to 176° F. by dry- and moist-heat methods (station B)

Cooking method, cut, and thickness	Animals	Cooking time	Thiamine retention	Riboflavin retention
COOKED AT 350°				
Top round (semimembranosus), 1-1/2 inches:	*Number*	*Minutes*	*Percent*	*Percent*
Oven-braised	8	50	69	90
Oven-roasted	8	116	66	97
Bottom round (biceps femoris), 1-1/2 inches:				
Oven-braised	2	60	72	87
Oven-roasted	2	132	64	96
Bottom round (biceps femoris), 1-1/2 inches:				
Range-braised[1]	6	51	53	93
Broiled	6	92	47	92
COOKED AT 300°				
Top round (semimembranosus), 3 inches:				
Oven-braised	8	111	70	94
Oven-roasted	8	188	72	98
Bottom round (semitendinosus), 3 inches:				
Oven-braised	2	87	68	94
Oven-roasted	2	121	77	108

[1] Range-braised in 50 ml. of water.

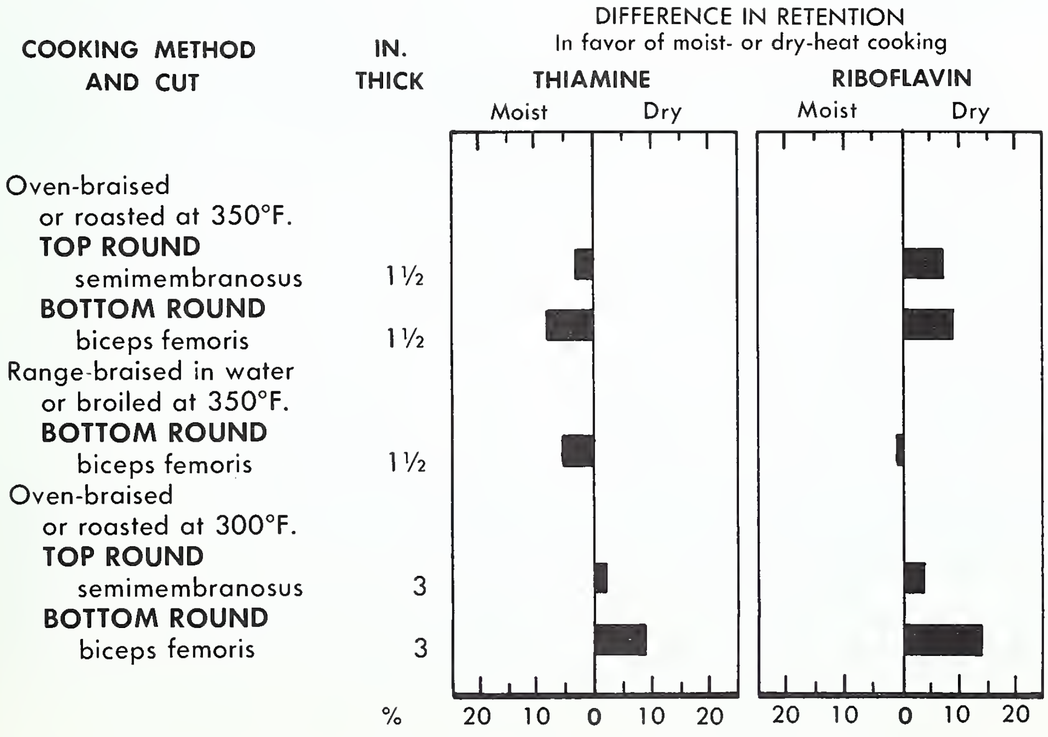

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FIGURE 14.--Comparison of retention of thiamine and of riboflavin in paired cuts of top and bottom rounds of beef cooked by dry- and moist-heat methods (station B).

biceps femoris. Also, average juiciness scores showed the broiled cut to be less juicy; broiled biceps femoris averaged 6.7, whereas roasted semitendinosus averaged 7.1.

Generally thin cuts cooked by dry heat retained slightly less thiamine and slightly more riboflavin than those cooked by moist heat; thick cuts cooked by dry heat had higher retention of both thiamine and riboflavin.

Stations G and B both reported that statistical analyses showed no significant differences in vitamin retention due to differences in dry- and moist-heat cooking methods as used in these studies. As noted, the time, temperature, and drip losses varied considerably within each method of cooking, so that no generalizations could be made in regard to the method that would be expected to give the best vitamin retention.

Station F studied the retention of thiamine and riboflavin in the braising of three cuts of meat from six dairy-type cows. Some of the cuts had not been frozen, some were frozen and thawed in the refrigerator, and some were frozen and cooked without prethawing. Cuts from chuck and top and bottom round were oven-braised at 300° F. to internal temperature of 209° and compared with paired cuts that were pressure-braised at 10 pounds pressure to 216°. Average retentions of thiamine and riboflavin according to cut, freezing treatment, and cooking method are given in table 22.

Thiamine retention was consistently higher in oven-braised that in pressure-braised cuts, but riboflavin was consistently lower. It could be that solubility losses were greater in oven-braising, but that heat destruction of thiamine was sufficiently high at 10 pounds pressure to more than offset the difference in solubility losses in the two types of braising.

Differences in retention of both thiamine and riboflavin in meat cooked from unfrozen cuts, refrigerator-thawed cuts, or cooking-thawed cuts were too small to be of statistical significance.

Nutritive value of steer beef and dairy-type cow beef.--That low-grade beef may be as high in thiamine and riboflavin as high-grade beef is shown by the comparison of three raw and cooked cuts of Commercial, Utility, and Cutter grade cow beef and Choice steer at station F. Although the vitamin content of beef was reported by several stations to vary among different cuts, average values among different grades of the same cut were

TABLE 22. --Average thiamine and riboflavin retention in three cuts of cow beef when oven-braised and pressure-braised after different freeze-thaw treatments (station F)

Cut and pretreatment	Thiamine retention		Riboflavin retention	
	Oven-braised	Pressure-braised	Oven-braised	Pressure-braised
	Percent	*Percent*	*Percent*	*Percent*
Top round:				
Unfrozen	40	33	60	66
Refrigerator-thawed	31	28	38	64
Cooking-thawed	38	28	54	58
Bottom round:				
Unfrozen	42	36	52	56
Refrigerator-thawed	34	24	36	56
Cooking-thawed	34	30	56	65
Chuck:				
Unfrozen	29	33	54	59
Refrigerator-thawed	36	24	42	58
Cooking-thawed	34	23	59	74
Average of three cuts:				
Unfrozen	37	34	55	60
Refrigerator-thawed	34	25	39	69
Cooking-thawed	35	27	56	66

very similar, as shown in table 23 (station F).

Retention during cooking was somewhat higher for thiamine and riboflavin in higher grade steer beef than in lower grades of cow beef (table 24). This was believed to be due to the heavier fat covering in the steer beef, which protected the lean and decreased solubility losses. However, when the proportion of fat in the cut is high, as in higher market-grade meat, the percentage of protein as well as of thiamine and riboflavin in raw meat as purchased is reduced correspondingly. The advantage of a protective coating of fat for higher retention of vitamins in cooking thus may be offset by a smaller amount of the vitamin-containing lean in the raw cut.

TABLE 23.--Average values for thiamine and riboflavin in raw and cooked cuts of steer and cow beef on dry, fat-free basis (station F)

Cut	Thiamine		Riboflavin	
	Steer beef[1]	Cow beef[2]	Steer beef[1]	Cow beef[2]
	Content (mg./100 gm.)[3]			
Raw:				
Top round......................	0.27	0.27	1.17	1.28
Bottom round..................	.27	.27	1.40	1.30
Chuck..........................	.27	.27	1.63	1.54
Cooked:				
Top round......................	.11	.10	.74	.73
Bottom round..................	.10	.11	.72	.76
Chuck..........................	.09	.08	.94	.88

[1] Choice grade.
[2] Commercial, Utility, and Cutter grades.
[3] Raw and cooked cuts were trimmed of visible fat before being sampled for vitamin determinations.

TABLE 24.--Retention of thiamine and riboflavin in cooked cuts of steer and cow beef (station F)

Cut[1]	Thiamine		Riboflavin	
	Steer beef[2]	Cow beef[3]	Steer beef[2]	Cow beef[3]
	Percent	*Percent*	*Percent*	*Percent*
Top round......................	37	34	67	56
Bottom round..................	38	34	65	56
Chuck..........................	35	30	76	61

[1] Raw and cooked cuts were trimmed of visible fat before being sampled for vitamin determinations.
[2] Choice grade.
[3] Commercial, Utility, and Cutter grades.

EFFECT OF COOKING METHOD AND GRADE ON YIELD OF COOKED MEAT

Yields of cooked meat tended to be higher from braising than from broiling, and, for the most part, were higher from oven-braising than from pressure-braising. Long cooking in an uncovered pan decreased yield of cooked meat. Thin cuts of beef gave better yields when cooked at a higher temperature for a short time. Yield of thick cuts was better at moderate cooking temperatures. Yield tended to be slightly higher in Prime and Choice grades than in lower grades of beef.

Data on cooking time, shrinkage, and yield of cuts of cooked beef from animals of Good grade and below, together with their moisture and fat contents, are presented in table 43 and are discussed here according to the cooking method including length of time for cooking and the cut of beef. Yield of cooked cuts of meat prepared by different methods could not be consistently associated with moisture or fat content of lower grade beef.

Braising versus broiling.--Yields of braised and broiled cuts are compared in figure 15. Top round steaks cut 3/4-inch thick gave a slightly higher yield of cooked meat when range-braised than when broiled well done at station G; yields of bottom round cooked by these two methods were the same. At station B where cuts were thicker and were cooked to certain predetermined end-point temperatures, yield of cooked meat of bottom round cut 1-1/2-inches thick was found to be significantly higher in range-braised than in broiled cuts. Less loss by evaporation is encountered when meat is range-braised, since it is covered in this method of cooking.

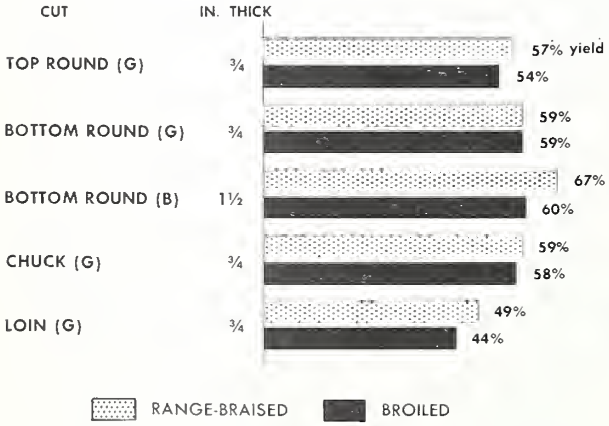

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FIGURE 15.--Yield of cooked meat from braised and broiled cuts of beef.

Thin cuts of loin braised with the bone in shrank less and gave higher yields than corresponding cuts cooked by broiling in studies at stations D and G; the difference was highly significant at station D (table 43).

Braising versus roasting.--Roasting temperature markedly affected the yield of cooked meat (figures 16 and 17). Top and bottom round cuts of steer beef shrank less during cooking and gave higher yields when roasted in a 300° F. oven to an internal temperature of 185° than when oven-braised at 300° or roasted at 250° to the same end-point temperature (station A). Roasting at 250° took considerably more time than roasting at 300°; the longer cooking time probably contributed to increased shrinkage and a lower yield of cooked meat for the cuts 1-1/2-inches thick.

Thickness of the cut influenced yield and cooking shrinkage. Cuts of top round 1-1/2 and 3-inches thick (station B) gave on the average approximately the same yields when oven-braised, whereas when roasted the 3-inch cuts gave higher yields. The 3-inch cuts of bottom round braised or roasted in a 300° F. oven to 176° gave higher yields than the 1-1/2-inch cuts cooked by these methods in a 350° oven but required more minutes per pound to reach the same internal temperature of 176° at the lower oven temperature (station B).

With 1-1/2-inch cuts of top and bottom round, oven-braising or roasting at 350° F. to an end point of 176° produced lower yields than those obtained when the oven temperature was 300° and the end point was 185°. When an oven temperature of 350° and an internal temperature of 176° were used, the yield of top round was lower for the roasted cuts than braised cuts; bottom round followed the same trend but differences were not significant (station B).

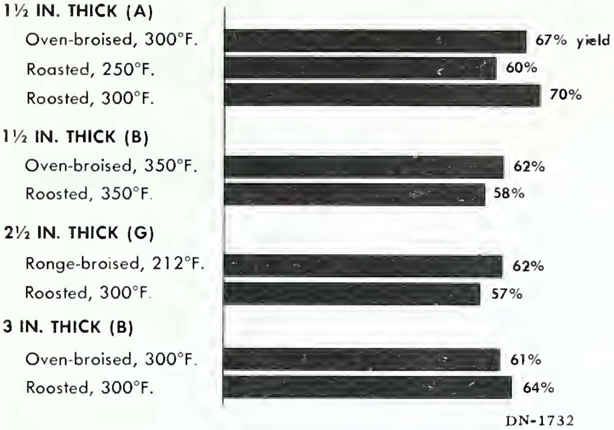

FIGURE 16.--Yield of cooked meat from braised and roasted cuts of beef--top round.

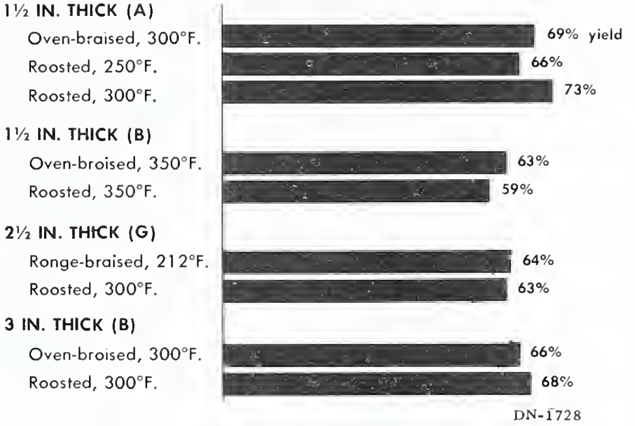

FIGURE 17.--Yield of cooked meat from braised and roasted cuts of beef--bottom round.

The reverse effect was obtained by cooking 3-inch cuts of top and bottom round at 300°--the total yield for roasted cuts was higher than for braised cuts (station B).

Regardless of thickness of cut or end-point temperature, the yield from bottom round cuts cooked by range-braising was comparable with the yield from those either oven-braised (station B) or roasted (station G) and was greater than that produced by broiling (station B).

Yield from oven-braising 3-inch semitendinosus muscles with water after browning and without water or browning were the same--66 percent in both cases (table 43, station B).

For thin cuts of meat the yield of cooked meat after roasting in a 450° F. oven, sometimes called oven-broiling, is compared with the effect after braising in a 250° oven in figure 18. Top and bottom round muscles of cow beef cut 1-inch thick shrank significantly less during roasting in a 450° oven to an end point of 160° than during braising in a 250° oven to 176° (station E). In fact, the biceps femoris muscle roasted at 450° produced the highest yield among all the cuts from both steers and cows reported in table 43. Thus, the thinner the cut the higher should be the temperature and the faster the cooking.

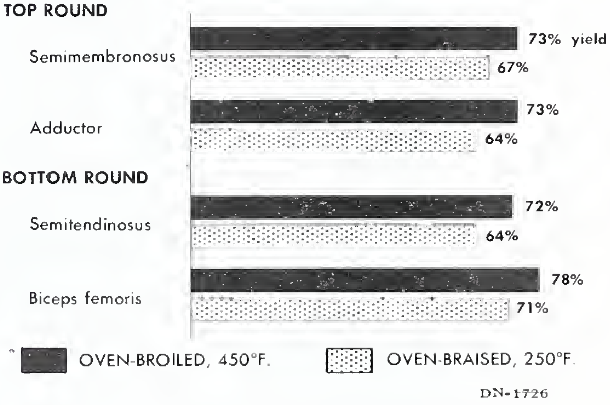

FIGURE 18.--Yield of cooked meat from 1-inch cuts of cow beef oven-broiled and braised (station E).

For thick cuts--3-inch rump--cooking time in minutes per pound was considerably less when roasted, 41 minutes, than for like cuts oven-braised, 62 minutes, but yield of cooked meat was practically the same for roasting and braising, 66 and 65 percent, respectively (table 43).

Thick cuts of loin gave a higher yield of cooked meat (station G) when range-braised to an end point of 199° F. than when roasted to an end point of 176°, which may be accounted for by the difference in cooking time (figure 19). Braised cuts required 75 minutes; roasted cuts, 218 minutes.

For the rib cut 2-1/2 to 3-inches thick, the total cooking loss was much higher for roasted than braised cuts. The difference could be attributed to the cooking time--93 minutes per pound was required for roasting, compared with 32 minutes for braising (station G). At station D, little difference was noted in the yield of cooked meat and bone resulting from oven-braising and roasting the rib cut; values were 72 and 71 percent, respectively, when cooking times were much the same, 272 and 309 minutes, respectively.

Oven-braising versus pressure-braising. --Yield of cooked meat appeared to have been affected by the method of braising, being slightly higher on the average for oven-braised cuts than for cuts braised at 10 pounds pressure, although there were exceptions depending on the cut used as noted below (table 25).

Thin cuts of bottom round pressure-braised at 5, 10, or 15 pounds to an end-point temperature of 185° F. yielded progressively less as the pressures were increased, and yields were all lower than those obtained by oven-braising (table 43, station A). Yields were 7 to 8 percent higher for oven-braised thin cuts of top and bottom rounds cooked to an internal temperature of 185° than for pressure-braised cuts at station A, whereas yields were practically the same at station D when the cuts were cooked a shorter time to 176° by these two methods.

Yield of 3-inch cuts of rump and heel of round were significantly higher when pressure-braised at 10 pounds pressure than when oven-braised at 300° F. (station D).

In experiments including both unfrozen and refrigerator-thawed meat at station F, pressure-braising did not produce as high yields as oven-braising, except for unfrozen cuts of top round. Most yields from unfrozen cuts were higher than those from refrigerator-thawed cuts cooked by comparable methods. For each method of cooking the bottom round drippings loss was greater from the cuts that were refrigerator-thawed before cooking than from the unfrozen cuts. This difference was not so noticeable for the top round or chuck cuts.

On the whole, yields from cuts of bottom round averaged consistently higher than those from corresponding cuts of top round.

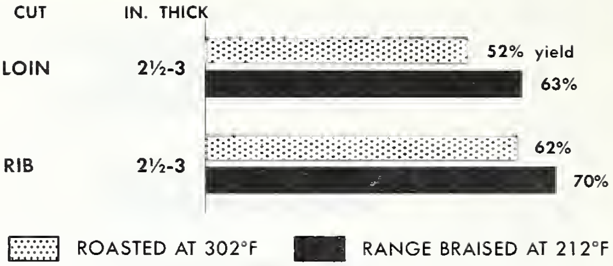

FIGURE 19.--Yield of cooked meat from braised and roasted cuts of beef--loin and rib (station G).

Among the steer chuck cuts of the same thickness, no outstanding effect of braising method on yield was apparent, except for frozen roasts thawed in the refrigerator before cooking. For these, oven-braised cuts averaged 67 percent yield of cooked meat compared with 55 percent for pressure-braised cuts.

The method of braising exerted no significant effect on the shrinkage of sirloin tip cuts of the same thickness.

Prime, Good, and Commercial grade cuts compared.--Data shown in tables 26, 27, and 28 provide a comparison of yields of meat in cooking cuts of Prime, Good, and Commercial grades of beef.

Roasted to an internal temperature of 158° F. yield by weight in Prime rib and loin cuts was similar to that in Commercial cuts, and was only 2 percent higher in cuts of Good grade (table 26). When the end-point temperature of roasting was increased to 194°, yields were 2 percent lower for Prime cuts. Braising cuts of round to 158° or to 194° resulted in similar yields of cooked meat, varying only by 1 or 2 percent.

Yields from both dry- and moist-heat methods of cooking thin cuts of beef round were consistently higher for Prime than for Commercial grade cuts (table 27).

In a comparison of lower grade cow beef and higher grade steer beef (table 28) braising resulted in somewhat higher yields in Choice than in lower grade Commercial, Utility, or Cutter grade cuts of top and bottom round and chuck.

Thus at three stations the higher grades of beef, with higher fat content, resulted in slightly higher yields of cooked meat than were obtained from lower grade beef.

TABLE 25.--Yield of cooked meat from oven- and pressure-braised boneless cuts of beef

Cut and station code	Oven-braised at 300° F.	Pressure-braised at 10 pounds
	Percent	*Percent*
Top round:		
1-1/2-inches thick (A)................	69	62
1-1/2-inches thick (D)................	66	67
4-pound roasts, unfrozen (F)..........	58	63
4-pound roasts, frozen, thawed in refrigerator (F)....................	60	58
Bottom round:		
1-1/2-inches thick (A)................	73	65
1-1/2-inches thick (D)................	70	69
4-pound roasts, unfrozen (F)..........	60	58
4-pound roasts, frozen, thawed in refrigerator (F)....................	57	54
Chuck:		
1-1/2-inches thick (D)................	68	67
3-inches thick (D)....................	68	69
4-pound roasts, unfrozen (F)..........	60	58
4-pound roasts, frozen, thawed in refrigerator (F)....................	67	55
Rump:		
3-inches thick (D)....................	70	75
Heel of round:		
3-inches thick (D)..................	69	74
Sirloin tip:		
1-1/2-inches thick (D)................	64	65
Average............................	65	64

TABLE 26.--Average fat content of raw beef and yield of roasted and oven-braised cuts of steer beef of different grades (station C)

Cut, cooking method, and end-point temperature (°F.)	Fat content of raw beef, dry-weight basis			Cooking time, total			Yield by weight after cooking		
	Prime	Good	Commercial	Prime	Good	Commercial	Prime	Good	Commercial
Rib and loin cuts roasted to:--	*Percent*	*Percent*	*Percent*	*Minutes*	*Minutes*	*Minutes*	*Percent*	*Percent*	*Percent*
158...............	23	16	12	237	153	198	81	83	81
194...............	23	13	12	363	244	300	66	68	68
Round cuts braised to:--									
158...............	20	15	9	139	111	136	76	74	74
194...............	19	10	10	180	133	174	67	66	65

TABLE 27.--Average cooking time and yield in cooking thin cuts of round of Prime and Commercial grade steer beef, oven-braised or roasted to 185° F. (station A)

Cooking method	Fat content, moist basis		Moisture content		Cooking time per pound		Yield by weight after cooking	
	Prime	Commercial	Prime	Commercial	Prime	Commercial	Prime	Commercial
	Percent	*Percent*	*Percent*	*Percent*	*Minutes*	*Minutes*	*Percent*	*Percent*
Raw..................	10	10	69	69	--	--	--	--
Oven-braised.........	19	17	55	53	35	36	75	68
Roasted at 250°......	21	16	52	50	251	268	69	63
Roasted at 300°......	19	15	55	56	55	60	76	72

TABLE 28.--Yield of cooked meat in braising three cuts of lower grade cow beef and higher grade steer beef (station F)

Cut	Fat content, moist basis		Moisture content		Yield by weight after cooking	
	Choice	Commercial, Utility, and Cutter	Choice	Commercial, Utility, and Cutter	Choice	Commercial, Utility, and Cutter
Top round:	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Raw................	4.1	3.4	71	72	--	--
Cooked.............	7.9	4.8	56	57	62	60
Bottom round:						
Raw................	4.4	2.9	72	72	--	--
Cooked.............	10.3	7.0	54	56	64	59
Chuck:						
Raw................	7.6	7.0	70	71	--	--
Cooked.............	11.8	9.1	53	54	62	60

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APPENDIX A--METHODS AND PROCEDURES

EXPERIMENTAL PROCEDURE

Procedures on the treatment, sampling, cooking, and panel evaluation of the cuts of beef used in the study are briefly presented for each station. Physical measurements and chemical methods employed are found in table 29, page 44.

TREATMENT AND SAMPLING OF THE CUTS

Station A.--Rounds were sliced so that each slice was divided immediately into top round, including the adductor and semimembranosus muscles, and bottom round, including the biceps femoris and semitendinosus muscles. The bone with adjacent small muscles was discarded. The samples were wrapped loosely in aluminum foil and stored in a refrigerator. Most of the cuts were cooked 6, 7, or 8 days after the animals were slaughtered; some samples of the first pair of rounds were cooked on the ninth day.

Top round was sampled by dividing the semimembranosus muscle into three parts by means of cuts perpendicular to the outside fat. The section nearest the adductor muscle and the bone was designated for chemical assay, the next for palatability, and the next for the shear-force test. In the bottom round, the shear samples were taken from the part of the biceps femoris nearest the bone, and the palatability samples from the adjacent part of the same muscle. For chemical assay of the bottom round the entire semitendinosus muscle was used.

The cooking methods were arranged in groups of 3 or 4, each group including a reference or standard method of braising. To avoid variation from rump to shank end within a group, the methods for the group were distributed among adjacent slices of the right and left rounds 1-1/2-inches thick. The groups were also alternated between top and bottom muscles in the various animals.

Station B.--Cuts were prepared from the rounds of eight carcasses 8 days after slaughter. The muscles chosen were semimembranosus, semitendinosus, and biceps femoris. Insofar as possible, the entire length of each muscle was stripped from the rounds along natural separations, leaving the fat adhering to the muscle intact. Samples were wrapped in freezer paper, frozen at -20° F., and held at 0° or lower until cooking tests were made. Left and right rounds were paired for comparing cooking methods. Duplicate cuts from each muscle were cooked by each method.

For physical and chemical tests, three cuts from 1- to 1-1/2-inches thick were taken from each muscle adjacent to and between the cuts used for cooking. A 1-inch core from the center raw cut was used for the shear-force test. After the test was made, the shear cores and the three raw cuts were composited for the fat, moisture, total nitrogen, thiamine, and riboflavin determinations.

The cuts were placed in a refrigerator at 46° F. to thaw for 48 hours before cooking. The thawing drip was added to the meat before cooking.

Station C.--After the carcasses had been stored from 7 to 10 days at about 35° F., cuts were removed and stored at -10°. Roasts were obtained from the rib, loin, and tenderloin. The longissimus dorsi muscle was used in both the rib and loin roasts, which were cooked with the bone left in the cut. The tenderloin and cuts from the round were obtained by dissecting the muscles from the carcass. Cuts were defrosted in the refrigerator 48 hours before they were to be cooked.

The 1-inch core for the shear-force tests was removed from the last section of the cut; then about 6 grams was removed for the press-fluid determination.

Station D.--Cuts were prepared from the carcasses of nine animals after storage at 34° to 36° F. for 6 days. Rib roasts and loin steaks from all animals and round steaks from the first six animals were stored in a refrigerator. These cuts were cooked between 8 and 14 days after slaughter. All other cuts were frozen and stored at 0° but were cooked within 6 weeks.

Samples for palatability studies, shear-force and press-fluid determinations, chemical analyses, and histological studies of the cooked meat and for chemical analyses on the raw meat were taken from the longissimus dorsi muscle of the rib roasts and loin steaks, the semimembranosus muscle of top round steaks, the biceps femoris (palatability, shear-force, and press-fluid samples) and the semitendinosus (chemical analyses and histological studies) muscles of the bottom round steaks, and from the gluteus medius muscle of the sirloin steaks.

For the chemical analyses, the entire slice of the muscle was used. Samples for all determinations made on chuck and sirloin tip steaks and rolled chuck and rump roasts were taken from approximately the same area, but the specific muscles used were not identified.

Samples of cooked meat, 1 inch in diameter and parallel to the fiber axis, were removed for the shear-force tests, one from each roast and two from each steak. To obtain the shear-force value for a cut, an average was taken of four or five shears on the sample or samples from each cut.

Fat and muscle sheath were trimmed from the cooked meat used for press-fluid determinations, duplicates of which were made on each sample.

Station E.--Carcasses were split after slaughter and hung as sides for 7 days in a meat cooler at 32° to 34° F. Muscles of the top and bottom round were removed from the carcasses, cut into 1-inch steaks, and stored on trays in the meat cooler. Two adjacent pairs of steaks were used at each of the storage periods studied. Seven 1/2-inch cores for each steak were taken for the shear-force determinations.

Station F.--Carcasses were aged at a temperature of 32° to 34° F. for 7 days. Wholesale cuts of top and bottom round and chuck from the carcasses were boned, the outer layer of fat was scored slightly, the cuts were rolled and then divided into roasts weighing approximately 4 pounds. The cuts that were to be cooked fresh were stored in a refrigerator at 40° to 50°. The others were frozen and stored at 0° for approximately 6 months before being tested.

For analyses on raw meat, slices 1-inch thick were thawed at room temperature during sampling procedures. For the shear-force determinations eight cores were cut from each slice. For chemical analyses and press-juice determinations, all visible fat and external cartilage were removed. The meat was then cut into 1-inch cubes. The cores of meat used for shear-force determinations were similarly cut and ground with the meat used for chemical analyses.

The cooked roasts were cut into thirds at right angles to the fiber of the meat. Each of the three slices was approximately 1-inch thick. Eight cores for the shear-force test were removed from one of these portions; the location of these cores was similar to that of the corresponding raw meat. The other portions were sliced and every second or third slice was used for palatability tests. The portions of the cooked roasts remaining were trimmed of visible fat, but no intramuscular fat was dissected out. The trimmed meat was cut, ground, and treated as described for the raw meat.

Station G.--Within 7 or 8 days after slaughter, four carcasses were each divided into wholesale cuts and then into steaks 3/4-inch thick and roasts 2-1/2-inches thick. Cuts were obtained from the rib, loin, top and bottom round, and chuck. The bone was left in the rib and the loin; the other cuts were boneless. The round was divided by removing and discarding the sirloin tip section in front of the femur, then separating along natural divisions so that the semimembranosus and a few smaller muscles were left in the top round, and the semitendinosus, biceps femoris, and the smaller muscles were left in the bottom round.

Two cores, 1-inch in diameter, were obtained from each cut. The cores from the thin cuts were so thin that only one shear from each core was obtained; the thick cuts were thick enough to allow four shears from each core.

COOKING METHODS

Moist-Heat Methods

Oven- or range-braising

Station A.--Meat was browned at 392° F. in 20 grams of beef fat for 7-1/2 minutes on each side, then cooked by braising in a tightly covered pan in 30 ml. of water in a 300° oven to an internal temperature of 176°, 185°, or 199°.

Station B.--After browning for 3 minutes on each side, the semitendinosus cuts for oven-braising were cooked in a covered glass casserole in a 300° F. oven to an internal temperature of 176°. Other cuts, the semitendinosus and biceps femoris, were braised at 212° on the surface of the range in 30 ml. of water to an internal temperature of 176°. Meat was also cooked in a 300° or 350° oven in a covered glass casserole without browning or added water to an internal temperature of 176°.

Station C.--Meat was browned for 12 minutes in 20 grams of fat (temperature 350° F.), then cooked in a covered pan in a 300° oven without added liquid to an internal temperature of 158° or 194°.

Station D.--Meat was browned in 20 grams of suet, then cooked in a covered enameled pan in a 300° F. oven to an internal temperature of 176°. Loin steaks and rib roasts were cooked without the addition of liquid, but 30 ml. of water was added to the less tender cuts.

Station E.--Steaks were browned for 3 minutes on each side, then cooked in covered Dutch ovens containing 50 ml. of water in a 250° F. oven to an internal temperature of 176°.

Station F.--Meat was browned for 2 minutes on each side in 20 grams of suet. Any drippings that accumulated while fresh meat was held in the refrigerator or during the refrigerator-thawing of frozen meat were poured over the roasts. No water was added in braising fresh meat or meat thawed in the refrigerator prior to cooking. To the frozen meat thawed during braising, it was necessary to add about 30 ml. of water to prevent scorching. The meat was cooked in a covered pan in a 300° F. oven to an internal temperature of 209°.

Station G.--Meat was browned in 1 tablespoon of cooking oil for 1 minute on each side, then placed on a rack in a heavy pot containing 1 cup of water, covered, and cooked at 212° F. on top of the range. Steaks were cooked for 45 minutes; pot roasts of chuck, rib, and loin were cooked to an internal temperature of 199°, while those from the top and bottom round were cooked to an internal temperature of 208°.

Pressure cooking

Station A.--Meat was browned for 7-1/2-minutes on each side and then cooked at 5, 10, or 15 pounds pressure to an internal temperature of 185° F. in a 2-1/2-quart pressure saucepan containing 30 ml. of water.

Station D.--Steaks and roasts cooked under pressure were browned in 20 grams of suet, placed on a rack in a pressure saucepan containing 20 ml. of water, and cooked at 10 pounds pressure to an internal temperature of 176° F. or 10 to 15 minutes per inch of thickness.

Station F.--Meat was browned for 2 minutes on each side in 20 grams of suet. To the frozen meat that had been thawed in the refrigerator before cooking, 59 ml. of water was added; 178 ml. of water was added to the frozen meat that was thawed during cooking. The roasts were cooked at 10 pounds pressure to an internal temperature of 216° F.

Dry-Heat Methods

Roasting

Station A.--Meat was roasted uncovered on a rack in a fry pan in a 250° or 300° F. oven to an internal temperature of 185°.

Station B.--Meat was roasted in an oven on the rack of a shallow uncovered pan, thick cuts at 300° F. and thin cuts at 350°, to an internal temperature of 176°.

Station C.--Meat was roasted on a rack in an uncovered pan in a 300° F. oven to an internal temperature of 158° or 194°.

Station D.--Rib roasts were placed fat side up and rolled rump roasts cut side up on racks in shallow roasting pans and cooked uncovered in a 300° F. oven to an internal temperature of 176°.

Station E.--The steaks were cooked uncovered on preheated racks in shallow pans in a 450° F. oven to an internal temperature of 160°.

Station G.--The meat was roasted on a rack in an uncovered pan in a 302° F. oven to an internal temperature of 176°.

Broiling

Station B.--Meat was broiled on the rack of a shallow pan in a gas broiler with the temperature at the surface of the rack maintained at approximately 350° F.

Station D.--Steaks were placed on the broiler rack of a gas range about 8 inches from the flame and cooked to an internal temperature of 176° F. In a second method of broiling, the meat was placed on a rack and cooked in a 300° revolving hearth oven to an internal temperature of 158° or 176°.

Station G.--Meat was broiled in the broiler compartment of an experimental gas oven-broiler unit. The bottom of the broiler pan was lined with aluminum foil. The top of the broiler rack was placed 4 inches from the gas openings. The compartment was preheated to 392° F. for cooking and the broiler door was left open during preheating and broiling. Steaks were cooked approximately 25 minutes on one side, then turned and cooked approximately 10 minutes on the other side.

Special Treatments (station A)

Scoring.--Meat was pretreated before standard braising by scoring with a knife; scorings were approximately 1/4-inch deep and 3/4-inch apart.

Pounding.--Before braising, the meat was pounded 70 beats on each side with a metal pounder.

Enzymes.--Meat was sprinkled with 1-1/2 grams of commercial enzyme (derived from *Carica papaya*) and pierced thoroughly on both sides with a fork, then allowed to stand for 30 minutes at room temperature before cooking by the standard braising method. In a like manner, meat was treated with a papain mixture for comparison with the commercial preparation.

Braising with vinegar.--Meat was cooked by the standard braising method, using, instead of water, a mixture of 15 ml. of white distilled vinegar of 5 percent acidity, 15 ml. of water, and 24 grams of sugar.

Soaking in vinegar.--Meat was placed in a solution of 50 ml. of white distilled vinegar of 5 percent acidity and 50 ml. of water and stored for 48 hours in a refrigerator, during which time the meat was turned twice. After soaking, the meat was braised by the standard method, except that 30 ml. of the soaking solution and 24 grams of sugar were substituted for water.

Thawing (station F)

Refrigerator-thawed.--The roasts thawed in a refrigerator prior to cooking were removed from the freezer 30 to 42 hours before cooking.

Cooking-thawed.--The roasts thawed during cooking were removed from the freezer just long enough to permit weighing before cooking.

PANEL EVALUATION

At all stations palatability was determined by sensory testing methods, by taste panels composed of 4 to 10 members. Score cards contained 10-point numerical rating scales for quality characteristics of tenderness, juiciness, and flavor. Some stations used zero to describe an inedible product. The magnitude of differences in scores between paired cuts, therefore, was on the same basis for all stations. That is, a difference of 1.0 was 10 percent whether the actual scores were low or high, though the descriptive terms attached to the numerical ratings were not always the same.

Station A.--Meat was sliced while hot and served to the same seven women judges throughout the experiment. Aroma, flavor of lean, tenderness, juiciness, flavor of fat, and acceptability were scored by use of adjectives arranged on a 10-point scale, 10 being the highest (extremely good) and 1 the lowest score (extremely poor).

Station B.--A trained panel of at least five judges, both men and women, scored the meat on a 10-point scale for aroma, flavor, juiciness, and tenderness with descriptive terms from "excellent" to "extremely poor." A score of zero was used to designate inedible quality. Each judge had a slice from the same section of each cut.

Station C.--A trained panel of four judges scored the meat on a 10-point scale, ranging from extremely good to extremely poor for aroma, flavor of fat, flavor of lean, tenderness with the aid of "number of chews," and juiciness.

Station D.--Cooked meat was rated for aroma, flavor of lean and fat, tenderness, and juiciness by a panel of five judges. Scores were given within the range of 10 (extremely good) to 1 (extremely poor). Tenderness scores were given on the basis of the number of chews it took to completely masticate a bite of meat of a certain size.

Station E.--Cooked meat was rated for aroma, flavor of lean, tenderness, juiciness, flavor of fat, and general acceptability on a scale ranging from 10 (extremely good) to 1 (extremely poor). Five 1/2-inch slices were cut from the center of each steak. Each slice was divided for judging into three parts; the center 1-inch was cut out and used for testing the tenderness by recording the number of chews. Each judge rated one complete slice from the same position in each steak.

Station F.--The cooked meat was rated for aroma, flavor, juiciness, and tenderness on a scale ranging from 10 (perfect) to 1 (very poor), with zero being used to describe an unacceptable product. The panel was composed of trained judges--4 men and 6 women. The judges scored 4 samples of meat on each testing day; 2 were from the lower grade carcasses and 2 from the higher grade carcasses. One sample of each grade was oven-braised and one was pressure-saucepan braised. Slices of meat were randomized for serving to the judges.

Station G.--The cooked meat was rated by five judges for aroma, juiciness, flavor, and tenderness on a scale ranging from 10 (excellent) to 1 (very poor). Zero score indicated an unacceptable product. The judges scored small pieces of meat, not whole steaks or slices of roast. The pieces were obtained after the cores for the shearing tests had been removed. In thin cuts, the judges' samples were long narrow strips taken from the area between the cores. Each sample from a broiled steak was paired with a sample from a similar position in the braised steak. Each slice from an oven roast was also paired with a slice from a similar position in the braised roast.

TABLE 29. --Summary of methods used for physical and chemical determinations

Determination and station	Procedure
Shear force for tenderness:	
All stations..........................	Warner-Bratzler shear machine. Readings were made on cores 1 inch in diameter, except at Station E where they were 1/2 inch in diameter (7, 9, 10, 12, 14, 15, 20).
Press fluid:	
Stations D and F......................	Carver laboratory press. Determinations were made on 25-gram samples of ground meat at Station D, and on 50-gram samples at Station F (9, 12).
Station C.............................	Minnesota Pressometer. Determinations were made on 6-gram samples (15).
Moisture:	
Station E.............................	Part of the samples were dried with a Brabender semiautomatic moisture tester, part at room temperature over calcium chloride, and part under infrared lamps.
All other stations....................	A.O.A.C. method for drying in vacuum oven (2).
Fat:	
Station A.............................	Acid hydrolysis method used by the Quartermaster Corps (21).
Stations B and G......................	Soxhlet extractor on dried samples (2).
Station C.............................	Method of W. R. Bloor (5).
Station D.............................	Acid extraction (12).
Station E.............................	A.O.A.C. method, using the Bailey-Walker apparatus or an adaptation thereof (1).
Station F.............................	An adaptation of the Babcock method for milk (A.O.A.C.) (2).

TABLE 29.--Summary of methods used for physical and chemical determinations--Continued

Determination and station	Procedure
Total nitrogen:	
Stations B, D, and G	Kjeldahl-Gunning-Arnold method (2, 3).
Station F	Micro-Kjeldahl with slight adaptation (17).
Collagen:	
Stations A and C	Lowry, Gilligan, and Katersky method or an adaptation thereof (16).
Station D	Hartley and Hall method (13).
Elastin:	
Station C	An adaption of method of Lowry, Gilligan, and Katersky (16).
Thiamine:	
Station F	Thiochrome method. [Station B (4), and Station F (6).]
Stations B and G	Method of the Association of Vitamin Chemists (4).
Riboflavin:	
Station B	Fluorometric method (4).
Station F	Method of MacKinney and Sugihara (18).
Station G	Method of the Association of Vitamin Chemists (4).
Niacin:	
Station G	Method of the Association of Vitamin Chemists (4).
Pantothenic acid:	
Station G	Microbiological methods of Neal and Strong (19) and Strong, Feeney, and Earle (22).

APPENDIX B--HISTORY OF ANIMALS AND EFFECT OF FEED ON QUALITY OF BEEF

Available information on the history of the animals studied is found in table 30.

TABLE 30.--History of animals

Type and breed of animal and station code[1]	Feed	Age	Animals	Carcass weight	U. S. Carcass grade by system in effect[2]	
					Before 1950	In December 1950
	Unfinished (grass fed)					
STEER		Months	Number	Pounds		
Jersey-Angus or Hereford (B)	Bermuda, lespedeza, Dallis, Johnson, rye, fescue, and clover variously combined.	12-1/2 20 14-1/2 to 22	2 2 4	-- 703 and 797 565 to 794	Good Low Commercial Commercial	Good Commercial Commercial
Hereford and Shorthorn (D)	Bluestem pasture for animals of known grazing history. Some dry-lot feeding (silage, prairie hay, and soybean meal or cake) given, but animals slaughtered off grass.	36 30	2 1	576 and 646 670	Average Commercial Commercial	Commercial Commercial
Hereford (G)	Tobosa, buffalo.	18 to 24 18	1 1	371 320	Average Utility Utility	Utility Utility
COWS, DAIRY-TYPE						
Holstein (F)	Grass-fed, plus 16 percent dairy-ration (orchard grass, ladino clover).	60 78	1 1	760 796	Top Utility Low Utility	Utility Utility
Guernsey (E)	Bluegrass, alfalfa, brome, plus corn silage, mixed legume hay, grain ration.	48	1	550	Low Commercial	Commercial
Holstein (E)	Alfalfa, brome, plus oats, corn, and mixed hay.	60	1	--	Commercial	Commercial
	Finished in dry lot					
STEER						
Herford and Shorthorn (D)	Bluestem or rye pastures, plus various combinations of silage, prairie hay, alfalfa hay, corncob meal, cottonseed meal, and protein concentrate in the dry lot.	36 36 to 48 30 36	1 3 2 1	688 684 to 795 633 --	Low Commercial Average Commercial Commercial Commercial	Commercial Commercial Commercial Commercial
Hereford (F)	Bluegrass, clover, grain on pasture, ground corn and/or molasses, plus corn, protein supplement, linseed meal or hay in the dry lot.	18 to 20 18 18 to 20	4 1 1	440 to 682 608 537	Good Top Good Low Good	Choice Choice Choice
Hereford (G)	Over-grazed pastures of tobosa, buffalo, or vine mesquite, cottonseed plus cottonseed meal, ground sorghum (grain silage and fodder), and alfalfa hay in the dry lot.	24 24	1 1	640 444	Low Choice Commercial	Choice Good

See footnotes at end of table.

TABLE 30.--History of animals--Continued

Type and breed of animal and station code[1]	Feed	Age	Animals	Carcass weight	U. S. Carcass grade by system in effect[2]	
					Before 1950	In December 1950
COWS, DAIRY-TYPE	Finished in dry lot--Continued					
		Months	*Number*	*Pounds*		
Holstein (E)	Alfalfa, timothy, plus oats, corn, oil meal, mixed hay.	36	1	715	Commercial	Commercial
Holstein (F)	Limited pasture with mixed hay and corn silage, plus concentrate mixture (corn, oats, bean, etc.) in the dry lot.	69	1	797	Low Commercial	Commercial
Holstein (F)	Bluegrass and clover plus 16 percent dairy ration, plus hay, silage and grain mixed with 16 percent dairy ration in the dry lot.	72	1	636	Utility	Utility
Holstein (F)	Bluegrass and clover plus 16 percent dairy ration, plus 16 percent protein diet (corn, oats, hay, bran oil, meal and corn silage) in the dry lot.	72	1	666	Utility	Utility
Holstein (F)	Bluegrass and clover plus 16 percent dairy ration, plus 16 percent protein diet (corn, oats, hay, bran oil, meal and corn silage) in the dry lot.	132	1	669	Top Cutter	Cutter
COWS, BEEF-TYPE						
Angus (E)	Bluegrass, plus corn silage and mixed legume hay in the dry lot.	60	1	670	Average Commercial	Commercial
Hereford (E)	Bluegrass, plus corn silage and mixed legume hay in the dry lot.	96	1	1010	Average Commercial	Commercial
Aberdeen Angus (E)	Mixed grass, plus corn silage and mixed hay in the dry lot.	120	1	700	Commercial	Commercial
	Feeding history unknown					
STEER						
Hereford (A)	----	24	2	578 and 582	Average Prime	Prime
		24	1	572 to 587	Low Commercial	Commercial
		42	3			
Hereford (C)	From Kansas farm, Iowa State College herd, and commercial packing company	17 to 18-1/2	2	638 and 665	Low Choice	Prime
		6	1	304	Average Commercial	Good
		18	1	401	High Commercial	Good
		5 - 6	1	208	Low Commercial	Commercial
		19	1	437	Low Commercial	Commercial
		42 to 48	1	623	Average Commercial	Commercial
		42 to 48	1	791	Low Commercial	Commercial

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[1] Institutions at which the research was done under contract or cooperative agreement are indicated by letters in parentheses: A, University of Chicago; B, University of Georgia; C, Iowa State University; D, Kansas State University; E, Michigan State University; F, New York State College of Home Economics, Cornell University; G, Texas Agricultural Experiment Station.

[2] U. S. carcass grades by system in effect from December 29, 1950, to June 1, 1956 are used throughout this publication. Animals under 48 months of age in the Commercial grade would now be called Standard grade.

Dry-lot finishing resulted in animals with somewhat better marbling of fat in the meat which, when cooked under standardized conditions, was rated similar in flavor but slightly higher in tenderness and juiciness than comparable cuts from animals slaughtered off grass.

A few stations in this study used animals off different feeds, making it possible to observe some effects of feed on the eating quality, chemical composition, and nutritive value of the beef. The effect of feed on the chemical composition of the meat was most pronounced in relation to the fat content of the raw cuts (table 31).

Unfinished steers at station B fed a variety of grasses achieved a finish comparable to or better than that of the animals from other locations receiving dry-lot feeding, as indicated by the fat content of the untrimmed cuts. At two locations, however, the fat content was higher in cuts from dry-lot-fed animals than in those from animals slaughtered off grass (station D, trimmed cut, and station G, partially trimmed cut). Ration containing corn and protein supplement, after grass feeding with supplement, was productive of the highest fat content in trimmed cuts from dry-lot finished steers (station F).

Total nitrogen values were similar for all cuts but tended to be slightly lower in cuts from steers off over-grazed pasture (station G) and slightly higher in beef round from steers receiving bluegrass, clover, corn, and molasses plus a dry-lot finish of corn, linseed meal, and hay (station F).

Collagen content as percentage of total nitrogen was comparatively higher in cuts from unfinished than in those from finished animals (station D) (table 32).

Thiamine values were relatively higher in unfinished grass-fed steers from station B than in those from other locations. No other consistent effect of feed on thiamine content was observed.

An appraisal of the riboflavin content of steer beef shows highest average values in cuts from animals fed bluegrass, clover, and molasses plus a dry-lot ration of corn, linseed meal, and mixed hay (station F). Riboflavin content of cow beef was found to be highest in cuts from animals off limited pasture with mixed hay and a mixture of corn silage and a dry-lot feeding of concentrate mixture consisting of corn, oats, and bran (station F).

Average values for palatability and cooking losses are given in table 33. Differences in average values of intramuscular fat in the paired raw cuts, and panel scores and shear-force values of paired cooked cuts, from finished and unfinished animals are given in table 34.

Grass plus dry lot compared with grass.--The effect of feed on the quality of the meat may be seen from data on roasted and braised cuts from four 2-year-old steers (station G). The two slaughtered off grass were graded Utility, whereas the two slaughtered off grass plus dry lot were graded higher--one Good and the other Choice.

Roasted cuts from animals finished on dry lot were higher in fat content (table 34) and, with the exception of loin, had lower cooking losses (table 33). Measured by shear force, tenderness was greater (lower shear force) in rib and loin cuts from dry-lot-fed animals than from those that were grass fed but not in the top and bottom round (table 34). However, all roasted cuts considered, average values for shear force and palatability factors showed that the dry-lot finish seemed to result in slightly higher quality of meat.

When braised, rib and loin cuts from dry-lot feeding were more tender (lower shear force) than those from grass-fed animals, but top and bottom round cuts were not. In loin, where values for fat content and tenderness by shear force showed a usual increase over these values from unfinished animals, panel tenderness scores for the cuts from finished animals were also appreciably higher. In general, however, when the meat was braised the average values for palatability were not influenced much by the feed of the animal.

Grass plus supplement and dry lot compared with grass plus dry lot.--The six animals in the second comparison shown in table 3 were from 18 to 20 months old and were graded Choice (station F). Both groups had been finished on dry lot, but four animals had received supplement with grazing while two had not. Top round, bottom round, and chuck from these animals were used for fat analyses and braised to 209° or 216° F. for palatability tests.

Raw, cuts of top round and chuck from supplement-fed animals averaged higher in fat content than those without supplement, but cuts of bottom round did not. In the cooked meat, neither shear force nor palatability factors seemed associated

TABLE 31.--Effect of feed on the chemical composition and nutritive value of selected cuts of raw beef

Type of animal, feed, grade, cut of beef, and station code[1]	Animals	Moisture	Fat, moist basis[2]	Nitrogen, moist basis	Thiamine	Riboflavin
STEER						
Bermuda, lespedeza, Dallis, and fescue--summer grazing; crimson clover--winter grazing (B):						
Good:	*Number*	*Percent*	*Percent*	*Percent*	*Mg./100 gm.*	*Mg./100 gm.*
Top round	2	73.4	5.9	3.3	0.19	0.13
Bottom round	2	71.6	7.8	3.2	.23	.09
Bermuda, Johnson, lespedeza--summer grazing; fescue, rye, clover--winter grazing (B):						
Commercial:						
Top round	2	68.2	10.2	3.0	.22	.10
Bottom round	2	67.4	10.1	3.3	.14	.08
Bermuda, Johnson, lespedeza--summer grazing; fescue, rye, clover--winter grazing. Dry-lot fed 3 days before slaughter (B):						
Commercial:						
Top round	2	75.3	2.7	3.3	.15	.10
Bottom round	2	73.5	5.3	3.3	.15	.09
Bermuda, lespedeza, Dallis, and fescue--summer grazing; crimson clover--winter grazing (B):						
Commercial:						
Top round	2	72.4	5.4	3.5	.14	.14
Bottom round	2	70.7	7.4	3.4	.14	.16
Bluestem or rye pastures, where known (slaughtered off dry lot). Dry lot feeding variable (D):						
Commercial:						
Top round	6	73.1	2.5	3.6	--	--
Bottom round	6	73.4	3.0	3.5	--	--
Chuck	6	72.6	5.5	3.2	--	--
Rib	6	72.1	4.6	3.5	--	--
Loin	6	71.9	4.6	3.4	--	--
Bluestem pasture (slaughtered off grass). Dry-lot feeding: Silage, prairie hay, and cake or soybean meal daily (D):						
Commercial:						
Top round	3	74.1	1.7	3.6	--	--
Bottom round	2	74.0	2.4	3.6	--	--
Chuck	1	75.6	2.4	3.3	--	--
Rib	3	73.5	3.5	3.6	--	--
Loin	3	72.6	4.4	3.5	--	--
Over-grazed pasture; Tobosa, buffalo, vine mesquite. Dry lot feeding: Cottonseed, cottonseed meal, ground sorghum grain, alfalfa hay, sorghum silage, sorghum fodder (G):						
Choice:						
Top round	1	66.2	13.6	3.0	.09	.17
Bottom round	1	64.8	14.8	3.0	.10	.16
Chuck	1	65.6	14.6	2.9	.09	.20
Rib	1	58.0	25.2	2.5	.07	.16
Loin	1	59.6	21.8	2.7	.08	.14
Tobosa, buffalo. Dry lot feeding: Cottonseed, cottonseed meal, ground sorghum grain, alfalfa hay, sorghum silage, sorghum fodder (G):						
Good:						
Top round	1	60.9	20.2	2.7	.08	.19
Bottom round	1	61.6	19.2	2.9	.07	.18
Chuck	1	67.2	14.5	2.9	.09	.19
Rib	1	49.6	34.8	2.4	.06	.14
Loin	1	51.1	33.4	2.4	.07	.15
Tobosa, buffalo (G):						
Utility:						
Top round	1	68.3	11.8	2.9	.07	.16
Bottom round	1	70.0	8.8	3.2	.09	.17
Chuck	1	71.7	7.6	3.1	.10	.23
Rib	1	70.0	11.3	2.9	.07	.18
Loin	1	64.8	16.8	2.7	.08	.15

See footnotes at end of table.

TABLE 31.--Effect of feed on the chemical composition and nutritive value of selected cuts of raw beef--Continued

Type of animal, feed, grade, cut of beef, and station code[1]	Animals	Moisture	Fat, moist basis[2]	Nitrogen, moist basis	Thiamine	Riboflavin
STEER--Continued						
Grass (unknown). Dry lot feeding: Corn, 14 pounds; protein supplement, 1.25 pounds per day. (F):						
Choice:	*Number*	*Percent*	*Percent*	*Percent*	*Mg./100 gm.*	*Mg./100 gm.*
Top round	1	67.2	7.0	3.2	0.05	0.12
Bottom round	1	67.8	8.5	3.4	.07	.12
Chuck	1	65.2	12.0	3.5	.05	.11
Bluegrass, clover. Dry lot feeding: Corn, 12 pounds; linseed meal, 1.5 pounds; mixed hay, 6 pounds per day (F):						
Choice:						
Top round	1	73.4	1.5	3.4	.06	.30
Bottom round	1	72.6	4.5	3.5	.07	.31
Chuck	1	71.5	2.5	3.3	.06	.34
Bluegrass, clover; grain on pasture plus 8 pounds ground shelled corn per day for 3-1/2 months. Dry lot feeding: Corn, 14 pounds; protein supplement, 1.25 pounds per day (F):						
Choice:						
Top round	1	61.2	17.0	3.0	.04	.26
Bottom round	1	67.0	9.5	3.1	.06	.27
Chuck	1	69.2	19.5	2.8	.04	.25
Bluegrass, clover; grain on pasture plus 8 pounds ground shelled corn per day for 3-1/2 months. Dry lot feeding: Corn, 12 pounds; linseed meal, 1.5 pounds; mixed hay, 6 pounds per day (F):						
Choice:						
Top round	1	72.5	1.8	3.3	.07	.33
Bottom round	1	71.8	4.0	3.2	.07	.38
Chuck	1	68.4	7.5	3.1	.07	.36
Bluegrass, clover, plus 6.5 pounds corn plus 6 pounds molasses for 4 months. Dry lot feeding: Corn, 12 pounds; linseed meal, 1.5 pounds; mixed hay, 6 pounds per day (F):						
Choice:						
Top round	1	72.7	2.0	4.2	.06	.28
Bottom round	1	72.7	2.0	4.4	.06	.31
Chuck	1	73.3	4.5	3.6	.06	.36
Bluegrass, white clover plus 7 pounds molasses. Dry lot feeding: Corn, 12 pounds; linseed meal, 1.5 pounds; mixed hay, 6 pounds per day (F):						
Choice:						
Top round	1	73.3	1.8	3.6	.06	.40
Bottom round	1	76.0	2.5	3.6	.06	.38
Chuck	1	71.2	5.0	3.4	.06	.51
COW						
Orchard grass, ladino clover plus 16 percent dairy ration for 5 months (F):						
Utility:						
Top round	2	72.5	2.4	3.8	.08	.35
Bottom round	2	72.9	4.8	3.6	.08	.34
Chuck	2	72.4	4.8	3.4	.06	.38
Bluegrass, clover plus 16 percent dairy ration for 5 months. Dry lot feeding: Hay, corn, silage, and 16 percent mixed dairy ration, according to milk production for 3 to 4-1/2 months (F):						
Utility:						
Top round	2	69.1	9.0	3.4	.05	.17
Bottom round	2	70.0	6.2	4.2	.05	.17
Chuck	2	67.8	12.0	3.0	.05	.17

See footnotes at end of table.

TABLE 31.--Effect of feed on the chemical composition and nutritive value of selected cuts of raw beef--Continued

Type of animal, feed, grade, cut of beef, and station code[1]	Animals	Moisture	Fat, moist basis[2]	Nitrogen, moist basis	Thiamine	Riboflavin
COW--Continued						
Bluegrass, clover plus 16 percent dairy ration for 5-1/4 months. Dry lot feeding: Hay, corn, silage and 16 percent mixed dairy ration according to milk production for 7-3/4 months (F):						
Cutter:	*Number*	*Percent*	*Percent*	*Percent*	*Mg./100 gm.*	*Mg./100 gm.*
Top round	1	73.9	1.0	3.1	0.06	0.32
Bottom round	1	73.8	1.0	3.4	.05	.34
Chuck	1	70.7	9.5	3.2	.05	.33
Limited pasture with mixed hay and corn silage; concentrate mixture according to milk production, approximately 6 pounds per day for 4-1/2 months. Dry lot feeding: Concentrate mixture (corn, oats, bran), 2 pounds per day for 1-1/2 months (F):						
Commercial:						
Top round	1	73.8	8.5	3.9	.07	.41
Bottom round	1	73.1	4.0	3.8	.07	.42
Chuck	1	71.7	5.2	3.6	.07	.48

[1] See table 30, footnote 1, page 48.

[2] Samples for fat analysis: not trimmed of exterior fat at stations A and B; partially trimmed at station G; and trimmed of exterior fat at stations C, D, and F.

TABLE 32.--Collagen content of cuts from finished and unfinished steer beef of Commercial grade (station D)

Feed of animal	Cut of beef	Animals	Collagen content as percentage of total nitrogen
		Number	*Percent*
Finished in dry lot:			
Bluestem or rye pastures plus dry-lot feeding.	Top round	6	8.6
	Bottom round	6	9.2
	Chuck	6	10.2
	Rib	6	8.8
	Loin	6	9.0
Unfinished grass fed:			
Bluestem pasture; some dry-lot feeding but slaughtered off grass.	Top round	3	10.6
	Bottom round	2	11.2
	Chuck	1	13.7
	Rib	3	10.8
	Loin	3	12.1

with fat content of the raw muscle. However, all of these animals were graded Choice, and shear-force values (table 33), ranging from 4 to 11 pounds, showed all cuts to be very tender. After the prolonged cooking necessary to obtain an internal temperature of 209° to 216° F., shear-force values and palatability scores did not differentiate between meat from animals from different husbandry practices.

Grass plus supplement and dry lot compared with grass plus supplement.--Of nine 3-year-old steers slaughtered at station D, three were off grass with winter supplement and six were off grass with winter supplement followed by various types of dry-lot feeding, and the carcasses from all nine animals were graded Commercial.

When panel scores for palatability of the meat were averaged for each group, only slight differences were seen (table 34). Cuts from animals slaughtered off the dry lot contained higher amounts of fat than those from animals slaughtered off grass with supplement, and there was a tendency for slightly increased juiciness for both braised and roasted cuts. Tenderness was generally somewhat improved by dry-lot feeding of the animals as evidenced by both score and shear force differences.

TABLE 33.--Effect of feed on the tenderness, juiciness, flavor, and cooking loss of steer and cow beef cooked by dry- and moist-heat methods

Type of animal, feed, grade, cut of beef, and station code[1]	Age of animal	Animal	Panel scores for--			Shear force	Cooking loss	
			Juiciness	Flavor	Tenderness		Total	Drippings
	Cooked by dry-heat method (roasted or broiled)							
STEER								
Grass:								
Good (B):	*Months*	*Number*				*Pounds*	*Percent*	*Percent*
Top round........................	12-1/2 and 15-1/2	2	7.7	8.0	7.1	17.1	34.9	4.8
Bottom round.....................			6.4	7.8	6.8	23.9	46.6	8.8
Commercial (B)								
Top round........................	14-1/2 to 22	6	5.8	7.6	6.9	16.5	40.9	5.2
Bottom round.....................			6.6	7.7	7.3	14.9	36.4	4.3
Utility (G):								
Top round........................	18 to 24	2	3.4	6.6	6.6	21.4	45.6	--
Bottom round.....................			5.4	6.2	5.7	20.1	37.0	--
Chuck............................			5.8	6.4	8.0	16.2	39.0	--
Rib..............................			6.6	6.8	5.0	27.2	33.5	--
Loin.............................		1	7.6	7.4	5.4	33.2	34.0	--
Grass with supplement:								
Commercial (D):								
Rib..............................	30 to 36	3	7.0	8.2	8.3	16.9	25.1	7.5
Loin.............................			7.1	8.0	7.7	17.6	31.1	11.3
Grass, dry lot:								
Choice (G):								
Top round........................	24	1	4.2	7.9	7.2	26.6	41.0	--
Bottom round.....................			5.8	6.4	6.5	19.4	34.0	--
Chuck............................			6.5	7.0	8.8	14.6	38.0	--
Rib..............................			5.1	6.3	5.6	20.9	34.0	--
Good (G):								
Top round........................	24	1	6.6	7.8	6.2	20.6	37.0	--
Bottom round.....................			6.0	6.2	4.4	32.0	37.0	--
Chuck............................			5.0	7.6	3.8	--	30.0	--
Rib..............................			7.2	7.4	7.4	15.6	32.0	--
Loin.............................			7.0	8.4	8.8	15.8	38.0	--
Grass with supplement and dry lot:								
Commercial (D):								
Top round........................	36 to 48	5	--	--	--	--	--	--
Bottom round.....................			--	--	--	--	--	--
Chuck............................			--	--	--	--	--	--
Rib..............................		6	7.1	8.3	8.3	13.2	28.0	9.6
Loin.............................			7.2	8.2	7.5	18.2	33.8	12.4
COW								
Grass:								
Commercial (E):								
Top round........................	48 and 60	2	6.4	6.2	5.4	10.7	28.4	--
Bottom round.....................			6.5	5.8	4.8	11.9	24.4	--
Grass, winter supplement:								
Commercial (E):								
Top round........................	36 to 120	4	7.1	5.9	5.4	10.7	26.4	--
Bottom round.....................			6.8	5.8	4.4	11.7	25.6	--
	Cooked by moist-heat method (braised in range, oven or pressure cooker)							
STEER								
Grass:								
Good (B):								
Top round........................	12-1/2 and 15-1/2	2	6.5	7.1	6.5	15.9	36.0	23.2
Bottom round.....................			7.5	7.2	7.3	21.3	32.8	16.7
Commercial (B):								
Top round........................	14-1/2 to 22	6	6.0	7.4	6.9	18.7	39.6	25.5
Bottom round.....................			6.9	7.2	7.0	15.9	34.0	18.3
Utility (G):								
Top round........................	18 and 24	2	3.9	5.8	6.4	21.0	39.5	--
Bottom round.....................			5.4	6.6	6.3	14.8	36.5	--
Chuck............................			6.2	7.0	7.5	16.5	34.5	--
Rib..............................			5.8	7.6	5.7	26.5	27.5	--
Loin.............................		1	5.4	6.2	4.2	34.2	30.0	--

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[1] See table 30, footnote 1, page 48.

TABLE 33.--Effect of feed on the tenderness, juiciness, flavor, and cooking loss of steer and cow beef cooked by dry- and moist-heat methods--Continued

Type of animal, feed grade, cut of beef, and station code[1]	Age of animal	Animal	Panel scores for--			Shear force	Cooking loss	
			Juiciness	Flavor	Tenderness		Total	Drippings
	Cooked by moist-heat method (braised in range, oven or pressure cooker)--Con.							
STEER--Continued								
Grass with supplement:								
Commercial (D):	*Months*	*Number*				*Pounds*	*Percent*	*Percent*
Top round	30 to 36	3	4.5	6.8	6.1	21.6	33.5	--
Bottom round		3	5.0	7.2	6.6	19.2	29.3	--
Chuck		1	5.2	7.2	6.0	17.3	32.6	--
Rib		3	6.5	8.1	7.7	20.5	27.0	--
Loin		3	6.3	7.8	6.7	18.6	28.9	--
Grass, dry lot:								
Choice (F):								
Top round	18 and 20	2	5.8	7.2	7.6	10.7	38.8	16.8
Bottom round			6.4	7.1	7.9	7.6	35.8	9.8
Chuck			7.4	7.8	8.4	4.8	39.2	11.5
Choice (G):								
Top round	24	1	4.4	7.6	6.6	28.9	38.0	--
Bottom round			5.8	7.8	7.6	13.6	35.0	--
Chuck			6.1	6.9	7.9	15.0	32.0	--
Rib			5.2	7.1	5.1	25.5	24.0	--
Good (G):								
Top round	24	1	4.2	7.0	6.2	22.0	35.0	--
Bottom round			5.4	7.4	6.6	18.0	34.0	--
Chuck			4.6	7.2	5.4	--	33.0	--
Rib			5.4	7.2	5.8	17.4	23.0	--
Loin			5.8	7.0	8.0	16.8	25.0	--
Grass with supplement and dry lot:								
Choice (F):								
Top round	18 to 20	4	5.4	6.6	7.3	11.3	37.4	14.0
Bottom round			6.6	7.0	8.3	6.9	35.2	13.1
Chuck			7.0	7.0	8.0	4.5	36.5	8.1
Commercial (D):								
Top round	36 to 48	5	5.0	7.0	6.2	17.9	33.0	--
Bottom round		5	5.3	7.2	6.3	21.5	31.4	--
Chuck		5	6.0	7.2	6.7	16.8	31.6	--
Rib		6	6.9	7.8	8.0	13.2	28.2	--
Loin		6	6.9	7.8	7.3	18.1	24.9	--
COW								
Grass:								
Commercial (E):								
Top round	48 and 60	2	3.9	6.0	5.1	11.4	33.1	--
Bottom round			3.8	5.6	3.9	11.4	30.2	--
Grass, winter supplement:								
Commercial (E):								
Top round	36 to 120	4	3.6	5.6	4.2	10.6	35.3	--
Bottom round			3.6	4.9	3.8	11.8	33.9	--
Grass with supplement:								
Utility (F):								
Top round	60 and 78	2	5.3	6.8	7.2	10.5	41.2	17.2
Bottom round			6.0	6.6	7.8	11.6	43.5	14.8
Chuck			6.8	7.0	7.6	8.1	41.2	19.5
Grass with supplement and dry lot:								
Commercial (F):								
Top round	69	1	4.7	5.9	6.0	21.8	40.5	25.0
Bottom round			4.6	6.1	6.2	16.2	42.5	21.5
Chuck			6.6	6.3	6.8	9.6	35.0	18.5
Utility (F):								
Top round	72	2	4.2	5.3	5.5	11.9	41.8	19.8
Bottom round			5.2	6.6	6.0	7.7	40.5	13.8
Chuck			5.5	6.0	6.0	8.1	42.8	15.5
Cutter								
Top round	132	1	4.4	6.1	6.1	17.0	31.0	22.5
Bottom round			4.2	5.6	4.8	21.0	40.5	13.0
Chuck			5.2	6.2	6.0	21.2	39.0	22.0

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[1] See table 30, footnote 1, page 48.

TABLE 34. --Fat content, and shear-force and palatability values compared for cuts of beef from animals differing in finish

Cooking method and cut	Increase (+) or decrease (-) in values as a result of dry-lot or supplement feeding				
	Fat content, raw (moist basis)	Shear force	Scores for --		
			Tenderness	Juiciness	Flavor
	Grass plus dry lot (Good, Choice) compared with grass (Utility)				
Roasted:[1]	*Percent*	*Pounds*			
Top round............	+1.2	+2.2	+0.1	+2.0	+1.2
Bottom round.........	+1.0	+5.6	-.3	+.5	+.1
Chuck................	+.9	-1.7	-1.7	0	+.9
Rib..................	+2.4	-9.0	+1.5	-.4	0
Loin.................	+1.3	-17.4	+3.4	-.6	+1.0
Braised:[2]					
Top round............	+1.2	+4.5	0	+.4	+1.5
Bottom round.........	+1.0	+1.0	+.8	+.2	+1.0
Chuck................	+.9	-1.4	-.9	-.8	0
Rib..................	+2.4	-5.1	-.3	-.5	-.4
Loin.................	+1.3	-17.4	+3.8	+.4	+.8
	Grass plus supplement and dry lot compared with grass plus dry lot (all Choice)				
Braised:[3]					
Top round............	+1.6	+0.6	-0.3	-0.4	-0.6
Bottom round.........	-2.4	-.7	+.4	+.2	-.1
Chuck................	+2.3	-.4	-.4	-.4	-.8
	Grass plus supplement and dry lot compared with grass plus supplement (all Commercial)				
Braised:[4]					
Top round............	+0.9	-3.8	+0.1	+0.5	+0.2
Bottom round.........	+.4	+2.2	-.3	+.3	0
Chuck................	+3.1	-.4	+.7	+.8	0
Rib..................	+.9	-7.3	+.3	+.4	-.3
Loin.................	+.2	-.5	+.6	+.6	0
Roasted or broiled:[5]					
Rib..................	+0.9	-3.7	0	+0.1	+0.1
Loin.................	+.2	+.6	-.2	+.1	+.2

[1] All cuts roasted to 176° F. (station G).

[2] Top and bottom round braised to 208°; other cuts to 199° (station G).

[3] Oven-braising to 209° and pressure-braising to 216° were averaged for this comparison (station F).

[4] Average of cuts oven- and pressure-braised to 176° (station D).

[5] Average of rib cuts roasted to 158° and 176°; average of loin cuts broiled to 158° and 176° (station D).

APPENDIX C--RESULTS: BASIC DATA

Basic data on the palatability, chemical composition, nutritive value, and yield of cooked meat from various phases of the research on beef are given in tables 35 to 43.

TABLE 35.--Relation of grade of beef to the fat content, juiciness, tenderness, flavor, and cooking loss of selected cuts of steer and cow beef

Description of beef and station code[1]	Age of animal	Animals	End-point temperature	Fat content, moist basis			Panel score for -			Shear force	Total cooking losses
				Raw[2]		Cooked	Juiciness	Tenderness	Flavor		
				Trimmed	Untrimmed						
Cooked by dry-heat method (roasted or broiled)											
STEER											
Prime (C):	*Months*	*Number*	°F	*Percent*	*Percent*	*Percent*				*Pounds*	*Percent*
Loin............	17 and 18-1/2	2	158° and 194°	7.2	--	10.5	6.0	8.5	8.0	13.3	27.0
Rib.............				6.1	--	9.9	6.3	8.5	8.2	15.6	27.0
Prime (A):											
Top round.......	24	1	185°	--	11.1	10.6	7.0	8.3	7.6	17.8	25.9
Bottom round....				--	13.6	29.0	6.5	8.0	7.7	18.2	29.4
Choice (G):											
Top round......	24	1	176°	--	--	--	4.2	7.2	7.9	26.6	41.0
Bottom round...				--	--	--	5.8	6.5	6.4	19.4	34.0
Chuck..........				--	--	--	6.5	8.8	7.0	14.6	38.0
Rib............				--	25.3	32.4	5.1	5.6	6.3	20.9	34.0
Good (C):											
Loin............	6 and 18	2	158° and 194°	4.1	--	6.8	5.9	6.9	7.0	18.8	26.2
Rib.............				3.2	--	3.7	5.6	6.0	7.0	26.7	21.0
Good (B):											
Top round.......	12-1/2 and 15-1/2	2	176°	--	6.0	8.8	7.7	7.2	8.1	17.1	34.9
Bottom round....				--	[3] 6.6	[3] 5.8	[3] 6.4	[3] 6.8	[3] 7.8	[3] 23.9	[3] 46.6
Good (G):											
Top round.......	24	1	176°	--	20.2	14.3	6.6	6.2	7.8	20.6	37.0
Bottom round....				--	19.2	16.1	6.0	4.4	6.2	32.0	37.0
Chuck...........				--	14.5	14.0	5.0	3.8	7.6	--	30.0
Loin............				--	33.5	43.0	7.0	8.8	8.4	15.8	38.0
Rib.............				--	34.8	31.1	7.2	7.4	7.4	15.6	32.0
Commercial (C):											
Loin............	5 to 48	4	158° and 194°	3.4	--	5.4	5.8	7.6	6.8	19.3	25.2
Rib.............				2.8	--	4.8	5.1	6.9	6.4	24.9	26.5
Commercial (B):											
Top round.......	14-1/2 to 22	[4] 6	176°	--	5.5	5.6	5.8	6.9	7.6	16.6	40.9
Bottom round....				--	8.0	8.6	6.7	7.2	7.7	15.0	36.3
Commercial (A):											
Top round.......	24 and 42	2	185°	--	8.0	14.8	6.0	6.9	7.2	23.2	35.0
Bottom round....				--	9.2	16.7	6.6	7.2	6.8	22.5	29.8
Commercial (D):											
Loin............	30 to 48	9	176°	4.6	--	8.3	7.1	7.6	8.2	18.0	32.9
Rib.............				4.4	--	8.7	7.1	8.3	8.3	14.5	27.0
Utility (G):											
Top round.......	18 and 24	2	176°	--	[5] 7.8	9.1	3.4	6.6	6.6	21.4	45.5
Bottom round....				--	[5] 8.8	10.2	5.4	5.7	6.2	20.1	37.0
Chuck...........				--	[5] 5.6	10.7	5.8	8.0	6.4	16.2	39.0
Loin............	18	1	176°	--	20.7	27.7	7.6	5.4	7.4	33.2	34.0
Rib.............	18 and 24	2	176°	--	10.6	15.4	6.6	5.0	6.8	27.2	33.5
COW											
Commercial (E):											
Top round.......	36 to 120	6	160°	--	--	--	7.2	5.2	6.8	11.7	27.9
Bottom round....				--	--	--	7.3	4.8	6.8	11.7	24.6
Cooked by moist-heat method (braised in range, oven, or pressure cooker)											
STEER											
Prime (C):											
Top round.......	17 and 18-1/2	--	158° and 194°	4.5	--	7.0	5.2	7.2	7.4	15.2	30.7
Bottom round....				6.6	--	8.9	5.7	7.6	7.8	17.0	27.3
Prime (A):											
Top round.......	24	2	185°	--	14.0	20.0	6.6	7.2	7.4	20.5	26.8
Bottom round....				--	11.9	18.6	6.7	7.0	7.4	20.1	24.8
Choice (F):											
Top round.......	18 to 20	6	209° and 216°	5.2	--	7.7	5.5	7.4	6.8	11.1	37.8
Bottom round....				4.9	--	10.5	6.6	8.2	7.0	7.1	35.4
Chuck..........				8.8	--	11.1	7.1	8.2	7.2	4.6	37.4

See footnotes at end of table.

TABLE 35.--Relation of grade of beef to the fat content, juiciness, tenderness, flavor, and cooking loss of selected cuts of steer and cow beef--Continued

Description of beef and station code[1]	Age of animal	Animals	End-point temperature	Fat content, moist basis			Panel score for -			Shear force	Total cooking losses
				Raw[2]		Cooked	Juiciness	Tenderness	Flavor		
				Trimmed	Untrimmed						
	Cooked by moist-heat method (braised in range, oven, or pressure cooker)--Continued										
STEER--Continued											
Choice (G):	*Months*	*Number*	°F	*Percent*	*Percent*	*Percent*				*Pounds*	*Percent*
Top round	24	1	208°	--	--	--	4.4	6.6	7.6	28.9	38.0
Bottom round				--	--	--	5.8	7.6	7.8	13.6	35.0
Chuck	24	1	199°	--	--	--	6.1	7.9	6.9	15.0	32.0
Rib				--	25.3	33.7	5.2	5.1	7.1	25.5	24.0
Good (C):											
Top round	6 and 18	2	158° and 194°	2.3	--	3.3	4.7	5.3	6.4	29.6	33.0
Bottom round				2.4	--	4.6	5.6	6.5	6.8	20.7	27.6
Good (B):											
Top round	12-1/2 and 15-1/2	2	176°	--	5.7	8.8	6.5	6.5	7.1	15.9	36.0
Bottom round				--	8.1	8.8	7.3	7.2	7.4	20.3	33.1
Good (G):											
Top round	24	1	208°	--	20.2	28.2	4.2	6.2	7.0	22.0	35.0
Bottom round				--	19.2	26.5	5.4	6.6	7.4	18.0	34.0
Chuck	24	1	199°	--	14.5	13.6	4.6	5.4	7.2	--	33.0
Loin				--	33.5	42.7	5.8	8.0	7.0	16.8	25.0
Rib				--	34.8	40.3	5.4	5.8	7.2	17.4	23.0
Commercial (C):											
Top round	5 to 48	4	158° and 194°	2.4	--	3.4	4.0	6.6	6.1	22.2	35.5
Bottom round				2.6	--	4.0	5.3	7.2	6.8	19.7	27.3
Commercial (B):											
Top round	14-1/2 to 22	6	176°	--	6.8	5.9	5.9	6.9	7.4	18.7	39.6
Bottom round				--	7.4	10.9	6.9	7.0	7.2	15.2	34.1
Commercial (A):											
Top round	24 to 42	4	185°	--	9.0	14.9	5.8	6.3	6.9	24.1	31.1
Bottom round				--	7.8	15.3	6.1	6.3	6.9	26.4	30.9
Commercial (D):											
Top round	30 to 48	8	176° or according to thickness	2.2	--	4.1	4.8	6.1	6.9	19.3	33.7
Bottom round	30 to 48	7		2.7	--	4.6	5.2	6.4	7.2	20.8	30.8
Chuck	36 to 48	6		5.0	--	10.7	5.8	6.6	7.2	16.9	31.8
Loin	30 to 48	6		4.4	--	8.4	6.8	7.2	7.8	18.2	25.6
Rib	30 to 48	6		4.7	--	10.4	6.8	8.0	7.9	14.4	28.0
Utility (G):											
Top round	18 and 24	2	208°	--	[5] 7.8	11.0	3.9	6.4	5.8	21.0	39.5
Bottom round				--	[5] 8.8	14.3	5.4	6.3	6.6	14.8	36.5
Chuck	18 and 24	2	199°	--	[5] 5.6	7.6	6.2	7.5	7.0	16.5	34.5
Loin	18	1		--	20.7	17.2	5.4	4.2	6.2	34.2	30.0
Rib	18 and 24	2		--	10.6	18.2	5.8	5.7	7.6	26.5	27.5
COW											
Commercial (E):											
Top round	36 to 120	6	176°	--	--	--	4.0	4.5	6.1	12.2	35.2
Bottom round				--	--	--	4.0	3.8	5.7	11.7	33.4
Commercial (F):											
Top round	69	1	209° and 216°	1.0	--	3.5	4.7	6.0	5.9	21.8	40.5
Bottom round				2.0	--	8.0	4.6	6.2	6.1	16.2	42.5
Chuck				6.0	--	11.5	6.6	6.8	6.3	9.6	35.0
Utility (F):											
Top round	60 to 78	4	209° and 216°	5.6	--	5.0	4.8	6.4	6.0	11.2	41.5
Bottom round				4.1	--	8.5	5.6	6.9	6.6	9.6	42.0
Chuck				7.9	--	8.2	6.1	6.8	6.5	8.1	42.0
Cutter (F):											
Top round	132	1	209° and 216°	1.0	--	1.0	4.4	6.1	6.1	17.0	42.0
Bottom round				1.0	--	3.0	4.2	4.8	5.6	21.0	40.5
Chuck				9.5	--	6.5	5.2	6.0	6.2	21.2	39.0

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[1] See table 30, footnote 1, page 48. [2] Samples for fat analysis: not trimmed of exterior fat at stations A and B; partially trimmed at station G; and trimmed of exterior fat at stations C, D, and F. [3] Data for biceps femoris muscle only. [4] Data included from the semitendinosus muscle from 2 animals only. [5] Data from 1 animal only.

TABLE 36.--Effect of moist- and dry-heat cooking methods on the tenderness, juiciness, and flavor of selected cuts from beef animals of Good grade and below

Description of beef, station code,[1] and cooking method (°F)	End-point temperature	Cuts	Tenderness		Juiciness		Flavor
			Panel score[2]	Shear force	Panel score[2]	Press fluid[3]	Panel score[2]
	Cooked to same end-point temperature						
STEER							
Top round:							
Good:							
1-1/2-inch-thick cuts, semimembranosus (B):	°F.	Number		Pounds		Percent	
Oven-braised at 350°	176°	4	6.4	17.7	6.7	--	7.0
Roasted at 350°			7.1	18.2	7.9	--	8.2
3-inch-thick cuts, semimembranosus (B):							
Oven-braised at 300°			6.6	14.1	6.3	--	7.2
Roasted at 300°			7.2	15.9	7.6	--	8.0
Commercial:							
1-1/2-inch-thick cuts, semimembranosus (B):							
Oven-braised at 350°	176°	10	8.0	27.0	7.2	--	7.4
Roasted at 350°			6.4	20.3	5.0	--	7.4
3-inch-thick cuts, semimembranosus (B):							
Oven-braised at 300°			7.2	15.0	5.9	--	7.3
Roasted at 300°			7.5	12.8	6.6	--	7.9
1-1/2-inch-thick cuts (A):							
Oven-braised at 300° in 30 ml. water	185°	2	5.8	27.8	5.4	--	6.4
Roasted at 250°			7.4	22.1	5.4	--	7.6
Roasted at 300°			6.4	24.2	6.6	--	6.8
Bottom round:							
Good:							
1-1/2-inch-thick cuts, biceps femoris (B):							
Range-braised at 212°	176°	4	6.8	21.3	7.5	--	7.2
Broiled at 350°			6.8	23.9	6.4	--	7.8
Commercial:							
3-inch-thick cuts, semitendinosus (B):							
Over-braised at 300°	176°	2	7.1	19.5	7.2	--	7.2
Roasted at 300°			7.8	17.4	7.1	--	7.9
1-1/2-inch-thick cuts, biceps femoris (B):							
Range-braised at 212°	176°	8	6.3	13.1	7.0	--	6.9
Broiled at 350°			6.9	15.3	6.9	--	7.6
Oven-braised at 350°		2	6.7	11.3	6.4	--	7.2
Roasted at 350°			7.8	11.6	5.6	--	7.6
1-1/2-inch-thick cuts (A):							
Oven-braised at 300° in 30 ml. water	185°	2	6.2	21.8	5.0	--	6.1
Roasted at 250°			7.2	18.6	6.5	--	6.6
Roasted at 300°			7.1	26.4	6.7	--	7.0
Sirloin:							
Commercial:							
1-1/2-inch-thick cuts (D):							
Oven-braised at 300°	176°	13	7.8	20.8	5.2	26.4	7.3
Roasted (oven-broiled) at 300°			8.1	18.4	5.7	20.4	7.9
Loin:							
Commercial:							
2-inch-thick cuts (D):							
Oven-braised at 300° without added liquid	176°	31	7.2	18.2	6.9	28.0	7.8
Broiled			7.3	19.1	7.0	25.2	8.2
Rump:							
Commercial:							
3-inch-thick cuts (D):							
Oven-braised at 300° in 30 ml. water	176°	7	8.6	11.5	6.0	17.6	7.8
Roasted at 300°			8.6	13.3	5.5	28.6	7.8
Rib:							
Commercial:							
3-rib cuts (D):							
Oven-braised at 300° without added liquid	176°	12	8.0	14.4	6.8	24.8	7.9
Roasted at 300°			8.2	13.2	6.8	28.4	8.2

See footnotes at end of table.

TABLE 36.--Effect of moist- and dry-heat cooking methods on the tenderness, juiciness, and flavor of selected cuts from beef animals of Good grade and below--Continued

Description of beef, station code,[1] and cooking method (°F)	End-point temperature	Cuts	Tenderness		Juiciness		Flavor
			Panel score[2]	Shear force	Panel score[2]	Press fluid[3]	Panel score[2]
	Cooked to different end-point temperatures						
COW							
Top round:							
Commercial:							
1-inch-thick cuts, adductor (E):	°F.	*Number*		*Pounds*		*Percent*	
Oven-braised at 250° in 50 ml. water	176°	18	5.0	11.2	3.3	--	5.6
Roasted at 450°	160°	18	6.2	10.4	6.8	--	6.0
1-inch-thick cuts, semimembranosus (E):							
Oven-braised at 250° in 50 ml. water	176°	30	4.0	11.6	4.1	--	5.8
Roasted at 450°	160°	30	4.5	11.3	7.0	--	6.2
Bottom round:							
Commercial:							
1-inch-thick cuts, biceps femoris (E):							
Oven-braised at 250° in 50 ml. water	176°	42	3.9	11.7	4.3	--	5.3
Roasted at 450°	160°	42	4.6	11.6	7.5	--	6.0
1-inch-thick cuts, semitendinosus (E):							
Oven-braised at 250° in 50 ml. water	176°	30	4.0	11.9	3.4	--	5.5
Roasted at 450°	160°	30	4.6	12.0	6.3	--	6.3
STEER							
Top round:							
Good:							
2-1/2-inch-thick cuts (G):							
Range-braised at 212° in 1 cup water	208°	1	6.2	22.0	4.2	--	7.0
Roasted at 302°	176°	1	6.2	20.6	6.6	--	7.8
Utility:							
2-1/2-inch-thick cuts (G):							
Range-braised at 212° in 1 cup water	208°	3	6.4	21.0	3.9	--	5.8
Roasted at 302°	176°	3	6.6	21.4	3.4	--	6.6
Bottom round:							
Good:							
2-1/2-inch-thick cuts (G):							
Range-braised at 212° in 1 cup water	208°	1	6.6	18.0	5.4	--	7.4
Roasted at 302°	176°	1	4.4	32.0	6.0	--	6.2
Utility:							
2-1/2-inch-thick cuts (G):							
Range-braised at 212° in 1 cup water	208°	3	6.3	14.8	5.4	--	6.6
Roasted at 302°	176°	3	5.7	20.1	5.4	--	6.2
Chuck:							
Good:							
2-1/2-inch-thick cuts (G):							
Range-braised at 212° in 1 cup water	199°	1	5.4	---	4.6	--	7.2
Roasted at 302°	176°	1	3.8	--	5.0	--	7.6
Utility:							
2-1/2-inch-thick cuts (G):							
Range-braised at 210° in 1 cup water	199°	3	7.5	16.5	6.2	--	7.0
Roasted at 302°	176°	3	8.0	16.2	5.8	--	6.4
Loin:							
Good:							
2-1/2-inch-thick cuts (G):							
Range-braised at 212° in 1 cup water	199°	1	8.0	16.8	5.8	--	7.0
Roasted at 302°	176°	1	8.8	15.8	7.0	--	8.4
Utility:							
2-1/2-inch thick cuts (G):							
Range-braised at 212° in 1 cup water	199°	1	4.2	34.2	5.4	--	6.2
Roasted at 302°	176°	1	5.4	33.2	7.6	--	7.4
Rib:							
Good:							
2-1/2-inch-thick cuts (G):							
Range-braised at 212° in 1 cup water	199°	1	5.8	17.4	5.4	--	7.2
Roasted at 302°	176°	1	7.4	15.6	7.2	--	7.4
Utility:							
3-inch-thick cuts (G):							
Range-braised at 212° in 1 cup water	199°	3	5.7	26.5	5.8	--	7.6
Roasted at 302°	176°	3	5.0	27.2	6.6	--	6.8

See footnotes at end of table.

TABLE 36.--Effect of moist- and dry-heat cooking methods on the tenderness, juiciness, and flavor of selected cuts from beef animals of Good grade and below--Continued

Description of beef, station code,[1] and cooking method (°F)	End-point temper-ature	Cuts	Tenderness		Juiciness		Flavor
			Panel score[2]	Shear force	Panel score[2]	Press fluid[3]	Panel score[2]
	Cooked well-done						
STEER							
Top round:							
Utility:							
3/4-inch-thick cuts (G):	°F.	Number		Pounds		Percent	
Range-braised at 212° in 1 cup water	--	1	5.0	19.75	3.4	--	7.2
Broiled, well-done	--	1	3.6	33.00	2.8	--	3.8
Bottom round:							
Utility:							
3/4-inch-thick cuts (G):							
Range-braised at 212° in 1 cup water	--	2	8.4	9.94	3.6	--	7.5
Broiled, well-done	--	2	3.9	23.69	5.2	--	4.4
Loin:							
Utility:							
3/4-inch-thick cuts (G):							
Range-braised at 212° in 1 cup water	--	4	6.5	18.61	3.7	--	7.8
Broiled, well-done	--	4	4.5	25.17	4.4	--	6.3

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[1] See table 30, footnote 1, page 48.

[2] Maximum possible score, 10.

[3] Measured as milliliters per 25 grams of cooked lean sample and expressed as percentage of sample for Station D.

TABLE 37.--Effect of oven- and pressure-braising on the tenderness, juiciness, and flavor of selected cuts from beef animals of Good grade and below

Decription of beef, station code,[1] and cooking method (°F)	End-point temper-ature	Cuts	Tenderness		Juiciness		Flavor
			Panel score[2]	Shear force	Panel score[2]	Press fluid[3]	Panel score[2]
	Cooked to approximately the same end-point temperature						
STEER							
Top round:							
Commercial:							
1-1/2-inch-thick cuts (D):	°F.	Number		Pounds		Percent	
Oven-braised at 300° in 30 ml. water............	176°	12	6.3	21.1	4.5	26.8	6.9
Pressure-braised at 10 pounds in 20 ml. water....			6.4	19.6	3.9	25.6	6.4
1-1/2-inch-thick cuts (A):							
Oven-braised at 300° in 30 ml. water............	185°	2	6.7	28.0	6.6	--	7.1
Pressure-braised at 5 pounds in 30 ml. water.....			5.8	24.2	5.4	--	6.3
Pressure-braised at 10 pounds in 30 ml. water....			6.2	22.2	5.4	--	7.0
Pressure-braised at 15 pounds in 30 ml. water....			6.0	24.0	6.6	--	7.1
Bottom round:							
Commercial:							
1-1/2-inch-thick cuts (D):							
Oven-braised at 300° in 30 ml. water............	176°	8	7.6	21.8	4.5	29.2	7.1
Pressure-braised at 10 pounds in 20 ml. water....			7.4	19.8	4.3	26.4	6.9
1-1/2-inch-thick cuts (A):							
Oven-braised at 300° in 30 ml. water............	185°	2	6.4	26.5	6.4	--	6.6
Pressure-braised at 5 pounds in 30 ml. water.....			5.6	28.9	6.0	--	6.6
Pressure-braised at 10 pounds in 30 ml. water....			5.0	25.0	5.0	--	6.4
Pressure-braised at 15 pounds in 30 ml. water....			6.0	24.6	5.6	--	7.2
Chuck:							
Commercial:							
1-1/2-inch-thick cuts (D):							
Oven-braised at 300° in 30 ml. water............	176°	16	6.4	19.5	5.6	24.0	7.2
Pressure-braised at 10 pounds in 20 ml. water, 10 minutes per inch of thickness..............	--	16	6.9	18.0	5.1	21.6	6.9
3-inch-thick inside cuts (D):							
Oven-braised at 300° in 30 ml. water............	176°	18	6.1	17.2	6.3	24.4	7.4
Pressure-braised at 10 pounds in 20 ml. water, 15 minutes per inch thickness.................	--	18	6.6	15.2	6.2	21.2	7.2
3-inch-thick outside cuts (D):							
Oven-braised at 300° in 30 ml. water............	176°	18	6.5	16.0	5.9	24.8	7.3
Pressure-braised at 10 pounds, in 20 ml. water, 15 minutes per inch of thickness..............	--	18	6.7	15.6	5.8	22.8	7.1
Sirloin:							
Commercial:							
1-1/2-inch-thick cuts (D):							
Oven-braised at 300°............................	176°	29	7.0	20.1	5.8	26.8	7.5
Pressure-braised at 10 pounds in 20 ml. water, 10 minutes per inch of thickness..............	--	29	7.1	18.4	5.3	24.0	7.1
Sirloin tip:							
Commercial:							
1-1/2-inch-thick cuts (D):							
Oven-braised at 300°............................	176°	21	6.3	21.6	5.2	26.8	7.1
Pressure-braised at 10 pounds in 20 ml. water, 10 minutes per inch of thickness..............	--	21	6.5	18.7	5.1	26.0	6.9
Oven-braised at 300°............................	176°	10	7.3	18.1	5.4	26.0	7.7
Pressure-braised at 10 pounds in 20 ml. water....	--	9	7.7	17.1	5.2	23.6	7.4
Rump:							
Commercial:							
3-inch-thick cuts (D):							
Oven-braised at 300° in 30 ml. water............	176°	12	7.1	16.6	6.1	28.4	7.7
Pressure-braised at 10 pounds in 20 ml. water, 15 minutes per inch of thickness..............	--	12	6.9	16.7	6.6	30.4	7.7
Heel of round:							
Commercial:							
3-inch-thick cuts (D):							
Oven-braised at 300° in 30 ml. water............	176°	12	6.1	20.2	5.3	24.8	6.9
Pressure-braised at 10 pounds in 20 ml. water, 15 minutes per inch of thickness..............	--	12	6.4	18.9	5.9	22.8	7.0

See footnotes at end of table.

TABLE 37.--Effect of oven- and pressure-braising on the tenderness, juiciness, and flavor of selected cuts from beef animals of Good grade and below--Continued

Description of beef, station code,[1] and cooking method (°F)	End-point temperature	Cuts	Tenderness		Juiciness		Flavor
			Panel score[2]	Shear force	Panel score[2]	Press fluid[3]	Panel score[2]
	Cooked to different end-point temperatures						
COW							
Top round:							
Commercial:							
4-pound cuts (F):	°F.	Number		Pounds		Percent	
Oven-braised at 300°, refrigerator-thawed........	209°	1	6.1	23.1	5.7	--	6.4
Pressure-braised at 10 pounds in 59 ml. water, refrigerator-thawed...........................	216°		5.8	20.5	3.7	--	5.4
Oven-braised at 300° in 30 ml. water, cooking-thawed...............................	209°	1	7.9	3.7	4.1	--	6.2
Pressure-braised at 10 pounds in 178 ml. water, cooking-thawed...............................	216°		7.1	20.1	5.5	--	6.2
Utility:							
4-pound cuts (F):							
Oven-braised at 300°, unfrozen and refrigerator-thawed...........................	209°	4	6.0	12.0	4.9	47.1	6.0
Pressure-braised at 10 pounds in 59 ml. water, refrigerator-thawed...........................	216°		6.7	10.4	4.7	47.8	6.2
Oven-braised at 300° in 30 ml. water, cooking-thawed...............................	209°	4	6.9	12.2	5.0	47.9	6.1
Pressure-braised at 10 pounds in 178 ml. water, cooking-thawed...............................	216°		7.2	10.7	4.9	45.4	7.1
Cutter:							
4-pound cuts (F):							
Oven-braised at 300°, unfrozen..................	209°	1	5.9	17.6	4.4	45.0	5.9
Pressure-braised at 10 pounds in 59 ml. water, unfrozen.......................................	216°		6.3	16.4	4.3	43.7	6.3
Oven-braised at 300° in 30 ml. water, cooking-thawed...............................	209°	1	5.7	18.8	4.4	30.8	6.4
Pressure-braised at 10 pounds in 178 ml. water, cooking-thawed...............................	216°		6.1	17.8	5.1	34.1	6.6
Bottom round:							
Commercial:							
4-pound cuts (F):							
Oven-braised at 300°, refrigerator-thawed........	209°	1	4.7	19.9	4.0	--	5.6
Pressure-braised at 10 pounds in 59 ml. water, refrigerator-thawed...........................	216°		7.6	12.6	5.1	--	6.6
Oven-braised at 300° in 30 ml. water, cooking-thawed...............................	209°	1	6.5	24.2	5.3	--	6.5
Pressure-braised at 10 pounds in 178 ml. water, cooking-thawed...............................	216°		6.0	17.0	4.7	--	5.8
Utility:							
4-pound cuts (F):							
Oven-braised at 300°, unfrozen and refrigerator-thawed..	209°	4	6.2	12.2	5.2	47.3	6.4
Pressure-braised at 10 pounds in 59 ml. water, refrigerator-thawed...........................	216°		7.6	7.0	5.9	47.1	6.9
Oven-braised at 300° in 30 ml. water, cooking-thawed...............................	219°	4	7.2	11.0	4.9	44.2	6.2
Pressure-braised at 10 pounds in 178 ml. water, cooking-thawed...............................	216°		6.6	11.8	5.7	47.1	6.7
Cutter:							
4-pound cuts (F):							
Oven-braised at 300°, unfrozen..................	209°	1	4.7	22.7	4.0	47.4	5.5
Pressure-braised at 10 pounds in 59 ml. water, unfrozen.......................................	216°	1	5.0	19.3	4.3	38.0	5.8
Oven-braised at 300°, in 30 ml. water, cooking-thawed...............................	209°	1	4.5	24.9	5.0	31.4	6.7
Pressure-braised at 10 pounds in 178 ml. water, cooking-thawed...............................	216°	1	7.3	14.9	6.4	31.9	7.0

See footnotes at end of table.

TABLE 37.--Effect of oven- and pressure-braising on the tenderness, juiciness, and flavor of selected cuts from beef animals of Good grade and below--Continued

Description of beef, station code,[1] and cooking method (°F)	End-point temperature	Cuts	Tenderness		Juiciness		Flavor
			Panel score[2]	Shear force	Panel score[2]	Press fluid[3]	Panel score[2]
	Cooked to different end-point temperatures--Continued						
COW--Continued							
Chuck:							
Commercial:							
4-pound cuts (F):	°F.	*Number*		*Pounds*		*Percent*	
Oven-braised at 300°, refrigerator-thawed........	209°	1	5.6	10.2	5.8	--	6.1
Pressure-braised at 10 pounds in 59 ml. water, refrigerator-thawed...........................	216°	1	7.9	9.1	7.3	--	6.5
Oven-braised at 300° in 30 ml. water, cooking-thawed................................	209°	1	6.8	8.2	6.5	--	5.7
Pressure-braised at 10 pounds in 178 ml. water cooking-thawed................................	216°	1	7.3	6.7	6.5	--	5.9
Utility:							
4-pound cuts (F):							
Oven-braised at 300°, unfrozen and refrigerator-thawed...........................	209°	4	6.8	6.5	6.0	46.6	6.5
Pressure-braised at 10 pounds in 59 ml. water, refrigerator-thawed...........................	216°	4	6.8	9.7	6.2	45.0	6.5
Oven-braised at 300° in 30 ml. water, cooking-thawed................................	209°	4	6.5	10.3	6.2	45.3	6.4
Pressure-braised at 10 pounds in 178 ml. water, cooking-thawed................................	216°	4	7.1	8.7	6.4	39.9	6.8
Cutter:							
4-pound cuts (F):							
Oven-braised at 300°, unfrozen...................	209°	1	4.9	31.4	4.6	34.8	6.0
Pressure-braised at 10 pounds in 59 ml. water, unfrozen......................................	216°	1	7.0	10.9	5.7	45.4	6.4
Oven-braised at 300° in 30 ml. water, cooking-thawed................................	209°	1	5.5	22.0	6.1	30.1	6.5
Pressure-braised at 10 pounds in 178 ml. water, cooking-thawed................................	216°	1	7.4	5.0	6.7	27.3	7.4

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[1] See table 30, footnote 1, page 48.

[2] Maximum possible score, 10.

[3] Measured as milliliters per 25 grams of cooked lean sample and expressed as percentage of sample for Station D; percentage of weight of 50 grams of sample for Station F.

TABLE 38. --End-point temperature as related to cooking time and cooking losses, collagen, and palatability characteristics of steer beef of Good grade and below

Cut of beef, station code,[1] age of animal, and end-point temperature (°F).	Cuts	Weight of cut	Total cooking time	Total cooking losses	Loss of collagen in cooking	Tenderness		Juiciness		Flavor
						Mean of judges' scores	Shear force	Mean of judges' scores[2]	Press fluid[3]	Mean of judges' scores[2]
	Oven-braised at 300° F.									
	Number	Pounds	Minutes	Percent	Percent		Pounds		Percent	
Top round, semimembranosus (C):										
5 to 6 months:										
158°	4	2-1/2 to 3-1/4	107	28.6	61	6.1	24.6	4.6	35.5	6.4
194°		2-1/4 to 3-1/4	134	36.4	85	6.2	26.2	3.6	28.4	6.1
18 to 19 months:										
158°	4	3 to 6	155	29.7	74	6.2	25.6	5.2	33.6	6.8
194°			183	36.8	86	6.1	26.1	3.9	26.6	6.2
42 to 48 months:										
158°	5	4 to 8	190	34.4	72	6.0	24.8	4.6	33.5	6.2
194°			232	41.1	86	6.6	20.6	3.4	27.2	5.4
Top round, semimembranosus (A):[4]										
42 months:										
176°	2	1-3/4 to 2	[5] 70	24.4	[5] 64	6.6	19.4	6.2	--	6.8
185°	2	2-1/4	65	32.6	[5] 40	7.4	19.5	6.2	--	7.5
199°	1	2-3/4	95	37.1	62	5.6	27.7	5.3	--	6.6
Bottom round, semitendinosus (C):										
5 to 6 months:										
158°	2	1 to 2-1/2	81	18.0	64	8.4	24.8	6.9	40.7	6.5
194°			100	29.1	94	7.6	20.4	5.4	32.6	6.8
18 to 19 months:										
158°	1	3-1/4 to 3-1/2	95	17.9	61	7.5	21.5	7.5	40.4	7.5
194°			140	30.6	90	6.8	24.3	4.0	33.2	6.5
42 to 48 months:										
158°	3	1-3/4 to 5	106	22.2	71	6.8	24.7	6.6	41.2	7.2
194°		2 to 5-1/4	159	33.4	92	6.9	23.8	3.5	33.7	6.3
Bottom round, biceps femoris (C):										
5 to 6 months:										
158°	4	1-1/2 to 3	84	21.6	86	7.7	15.0	6.7	36.9	7.4
194°		2 to 2-1/2	116	31.2	89	7.9	15.7	3.6	31.4	6.2
18-to 19 months:										
158°	4	3-1/2 to 4-1/2	127	23.6	68	6.8	17.5	6.6	35.6	7.6
194°		3 to 4-3/4	148	32.2	85	6.3	15.8	4.2	26.7	6.5
42 to 48 months:										
158°	5	3 to 6-1/2	156	28.5	78	6.5	22.0	6.0	36.9	6.5
194°		3 to 7	192	35.4	94	6.0	17.2	4.1	30.9	5.7
Bottom round, biceps femoris (A):[4]										
24 to 42 months:										
176°	2	1 to 1-3/4	36	19.5	44	6.0	33.5	6.5	--	6.8
185°		1-1/2 to 2	62	29.4	60	6.0	25.5	5.9	--	7.0
199°		2	76	34.6	81	6.0	21.8	5.2	--	6.6

See footnotes at end of table.

TABLE 38.--End-point temperature as related to cooking time and cooking losses, collagen, and palatability characteristics of steer beef of Good grade and below--Continued

Cut of beef, station code,[1] age of animal, and end-point temperature (°F.)	Cuts	Weight of cut	Total cooking time	Total cooking losses	Loss of collagen in cooking	Tenderness		Juiciness		Flavor
						Mean of judges' scores	Shear force	Mean of judges' scores[2]	Press fluid[3]	Mean of judges' scores[2]
	Roasted or oven-broiled at 300° F.[6]									
	Number	*Pounds*	*Minutes*	*Percent*	*Percent*		*Pounds*		*Percent*	
Bottom round, biceps femoris (B):[4]										
12-1/2 to 20 months:										
160°	6	--	--	29.8	--	7.2	21.8	8.2	--	6.9
176°		--	--	36.9	--	7.1	21.2	6.3	--	7.2
Rib (D):										
30 to 36 months:										
158°	6	5-1/4 to 8-1/2	224	19.5	+11	8.6	14.8	8.2	36.0	8.6
176°		6 to 8-1/2	299	26.9	1	8.3	19.1	6.9	30.0	8.2
Rib, longissimus dorsi (C):										
5 to 6 months:										
158°	2	4-1/4 to 5-1/4	190	17.1	75	7.4	26.1	5.5	37.6	6.6
194°		4 to 4-1/2	250	24.0	88	7.1	29.5	4.6	33.0	6.1
18 to 19 months:										
158°	2	4-1/2 to 6-1/2	229	16.2	69	5.8	24.6	6.6	44.7	7.4
194°		3-3/4 to 6	302	30.3	66	5.1	30.3	4.4	26.6	6.4
42 to 48 months:										
158°	3	6 to 9-1/2	284	23.7	46	7.4	22.4	6.6	42.6	7.1
194°		6-1/4 to 11	404	36.7	85	6.7	20.1	3.8	23.2	5.9
in, Club (D):[7]										
30 to 36 months:										
158°	6	1-1/4 to 1-3/4	82	19.0	--	8.8	15.8	8.5	38.0	7.9
176°		1-1/4 to 2	119	27.0	--	8.4	13.5	6.8	29.2	8.2
Loin, T-bone (D):[7] [8]										
30 to 36 months:										
158°	6	1-1/2 to 2-1/4	94	21.3	9	8.2	16.6	8.3	38.0	8.4
176°		1-1/4 to 2	130	29.2	11	7.7	16.2	6.8	28.8	8.2
Loin, Porterhouse (D):[7] [8]										
158°	6	1-1/2 to 2-3/4	103	22.5	9	8.2	15.1	7.9	35.6	8.3
176°		1-1/2 to 2-3/4	158	34.3	11	7.5	17.7	6.3	22.4	8.2
Loin, longissimus dorsi (C):										
5 to 6 months:										
158°	2	3-3/4 to 5	162	13.3	93	6.6	26.9	6.1	37.6	6.4
194°		3-3/4 to 4-1/2	252	26.6	86	6.8	23.3	4.4	31.4	6.0
18 to 19 months:										
158°	2	3 to 5	136	13.4	74	5.5	27.6	7.0	42.8	7.5
194°		3-1/4 to 4-3/4	242	28.8	84	4.6	23.9	5.0	28.3	6.8
42 to 48 months:										
158°	3	4-1/4 to 6	179	19.0	73	7.2	24.9	6.7	43.4	7.2
194°		5 to 6-1/4	290	32.2	91	7.0	19.9	4.0	30.5	6.3

Loin, psoas major (C):										
5 to 6 months:										
158°	2	2-1/2	[5] 145	22.4	64	9.1	15.6	7.5	41.0	7.9
194°		2	[5] 250	38.9	81	8.5	14.3	5.8	29.3	6.8
18 to 19 months:										
158°	2	2-1/2 to 3-1/4	125	19.8	80	8.5	13.0	7.9	47.3	8.1
194°		2-1/2 to 3-1/4	252	41.0	87	7.6	13.6	5.1	28.1	6.2
42 to 48 months:										
158°	3	2-1/4 to 3-3/4	174	23.8	65	8.6	14.6	7.1	39.7	7.6
194°		2-1/4 to 3-1/4	278	38.3	67	8.6	12.3	3.6	27.4	5.7

[1] See table 30, footnote 1, page 48.
[2] Maximum score 10.
[3] Measured as milliliters per 25 grams of cooked lean sample and expressed as percentage of sample for station D.
[4] Thickness of cut, 1-1/2 inches.
[5] Data available for one sample only.
[6] Oven temperature 300° F., except for bottom round for Station B which was roasted at 350°.
[7] Thickness of cut, 2 inches.
[8] T-bone and Porterhouse steaks combined for collagen analysis.

TABLE 39. --Effect of cooking method on the chemical composition of steer beef of Good grade and below

Description of beef, station code,[1] and cooking method (° F.)	Animals	Moisture	Fat[2]		Nitrogen			Collagen	
			Moist basis	Dry basis	Moist basis	Dry basis	Dry-fat-free basis	Moist basis	Percent of total N
Top round:									
Good:									
1-1/2-inch-thick cuts, semimembranosus (B):	*Number*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Raw	2	73.4	5.9	22.0	3.3	12.3	--	--	--
Oven-braised at 350° for 50 minutes to 176°		59.1	8.4	20.4	5.1	12.3	--	--	--
Roasted at 350° for 82 minutes to 176°		58.9	7.7	18.8	4.8	11.7	--	--	--
3-inch-thick cuts, semimembranosus (B):									
Raw	2	73.4	5.9	22.0	3.3	12.3	--	--	--
Oven-braised at 300° for 86 minutes to 176°		59.0	9.2	22.3	4.7	11.8	--	--	--
Roasted at 300° for 160 minutes to 176°		59.5	9.8	24.3	4.6	11.4	--	--	--
2-1/2-inch-thick cuts (G):									
Raw	1	60.9	20.2	48.9	2.7	7.4	14.5	--	--
Range-braised at 212° for 102 minutes to 208°		46.2	28.2	52.4	3.9	7.2	15.2	--	--
Roasted at 302° for 243 minutes to 176°		53.7	14.3	30.9	4.6	10.0	14.4	--	--
Roasts, semimembranosus (C):									
Raw	2	74.9	--	9.1	3.6	13.5	--	0.08	2.25
Oven-braised at 300° for 114 minutes to 158°		63.6	--	8.8	5.2	13.1	--	.04	.79
Oven-braised at 300° for 144 minutes to 194°		60.8	--	8.6	5.7	14.3	--	.02	.38
Commercial:									
1-1/2-inch-thick cuts, semimembranosus (B):									
Raw	6	72.0	6.1	20.8	3.3	12.0	--	--	--
Oven-braised at 350° for 53 minutes to 176°		57.5	6.1	14.2	5.5	13.0	--	--	--
Roasted at 350° for 128 minutes to 176°		55.7	6.0	13.2	5.8	13.2	--	--	--
3-inch-thick cuts, semimembranosus (B):									
Raw	6	72.0	6.1	20.8	3.3	12.0	--	--	--
Oven-braised at 300° for 198 minutes to 176°		59.2	5.8	14.1	5.5	13.4	--	--	--
Roasted at 300° for 198 minutes to 176°		59.6	5.3	12.9	5.3	13.1	--	--	--
1-1/2-inch-thick cuts, semimembranosus (A):									
Raw	2	69.4	9.1	29.6	3.2	--	--	[4] .72	[4] 3.68
Oven-braised at 300° for 65 minutes to 185°		47.5	24.4	45.6	4.3	--	--	[4] .19	[4] 1.21
Pressure-braised at 5 pounds for 36 minutes to 185°		56.1	12.0	26.4	4.7	--	--	[4] .33	[4] .66
Pressure-braised at 10 pounds for 32 minutes to 185°		51.8	14.4	28.8	5.1	--	--	[4] .20	[4] .87
Pressure-braised at 15 pounds for 40 minutes to 185°		52.8	15.6	33.0	4.7	--	--	[4] .26	[4] .78
1-1/2-inch-thick cuts, semimembranosus (A):									
Raw	2	68.6	10.6	32.7	3.3	--	--	1.01	4.96
Oven-braised at 300° for 60 minutes to 185°		54.6	14.0	30.8	5.0	--	--	.51	1.64
Roasted at 250° for 420 minutes to 185°		47.7	16.8	32.2	5.4	--	--	.40	1.20
Roasted at 300° for 95 minutes to 185°		56.8	13.0	29.9	4.8	--	--	.53	1.77
1-1/2-inch-thick cuts (D):									
Raw	3	73.9	1.9	--	3.6	--	--	--	9.5
Oven-braised at 300° in 30 ml. water for 50 minutes to 176°		57.8	5.3	--	5.7	--	--	--	10.2
Pressure-braised at 10 pounds in 20 ml. water for 12 minutes to 176°		58.2	4.3	--	5.7	--	--	--	10.0
Roasts, semimembranosus (C):									
Raw	4	74.1	--	9.0	3.3	13.3	--	.07	2.05
Oven-braised at 300° for 168 minutes to 158°		62.8	--	8.4	4.9	13.3	--	.02	.52
Over-braised at 300° for 201 minutes to 194°		60.5	--	8.5	5.3	13.8	--	.02	.29

Top round--Continued									
Utility:									
3/4-inch-thick cuts (G):									
Raw	1	68.3	11.8	36.8	2.9	9.3	14.8	--	--
Range-braised at 212° in 1 cup water for 45 minutes		53.9	13.1	28.4	5.1	11.2	15.6	--	--
Broiled, well-done, for 37 minutes		53.7	13.0	28.1	5.1	11.0	15.3	--	--
2-1/2-inch-thick cuts (G):									
Raw	1	71.8	7.8	26.4	3.1	11.1	15.1	--	--
Range-braised at 212° for 62 minutes to 208°		58.3	11.0	26.4	4.6	11.1	15.1	--	--
Roasted at 302° for 325 minutes to 176°		54.7	9.1	20.1	5.5	12.2	15.2	--	--
Bottom round:									
Good:									
1-1/2-inch-thick cuts, biceps femoris (B):									
Raw	2	72.8	7.2	26.2	3.2	11.6	--	--	--
Range-braised for 38 minutes in 50 ml. water to 176°		60.9	6.9	17.3	5.1	13.1	--	--	--
Broiled at 350° for 98 minutes to 176°		54.1	5.8	12.4	6.2	13.5	--	--	--
2-1/2-inch-thick cuts (G):									
Raw	1	61.6	19.2	48.2	2.9	7.9	15.2	--	--
Range-braised at 212° for 99 minutes to 208°		47.9	26.5	50.9	3.9	7.5	15.3	--	--
Roasted at 302° for 212 minutes to 176°		53.4	16.1	34.5	4.7	10.2	15.5	--	--
Roasts, biceps femoris (C):									
Raw	2	75.7	--	11.0	3.5	13.8	--	0.11	3.13
Oven-braised at 300° for 109 minutes to 158°		65.5	--	9.9	5.0	13.4	--	.05	1.02
Oven-braised at 300° for 124 minutes to 194°		60.5	--	15.2	5.3	13.0	--	.03	.56
3-inch-thick cuts, semitendinosus (B):									
Raw	2	70.5	8.5	28.7	3.3	11.2	--	--	--
Oven-braised at 300° for 64 minutes to 176°		60.7	9.6	24.5	4.4	11.2	--	--	--
Range-braised at 300° for 90 minutes to 176°		58.0	12.0	28.4	4.6	10.9	--	--	--
Roasts, semitendinosus (C):									
Raw	2	[4] 75.6	--	[4] 9.6	3.5	14.4	--	.11	3.04
Oven-braised at 300° for 105 minutes to 158°		[4] 67.1	--	[4] 12.2	4.1	[4] 10.8	--	[4] .06	[4] 1.60
Oven-braised at 300° for 120 minutes to 194°		[4] 64.7	--	[4] 10.1	5.7	13.9	--	.01	.19
Commercial:									
1-1/2-inch-thick cuts, biceps femoris (B):									
Raw	4	70.1	7.8	25.8	3.2	11.0	--	--	--
Range-braised for 60 minutes in 50 ml. water to 176°		57.7	11.7	27.0	4.8	13.2	--	--	--
Broiled at approximately 350° for 94 minutes to 176°		57.7	8.6	20.2	5.2	12.0	--	--	--
1-1/2-inch-thick cuts, biceps femoris (B):									
Raw	2	70.7	7.8	26.2	3.3	11.4	--	--	--
Oven-braised at 350° for 60 minutes to 176°		59.2	7.2	17.7	4.9	12.1	--	--	--
Roasted at 350° for 132 minutes to 176°		56.7	6.0	13.8	6.0	13.9	--	--	--
1-1/2-inch-thick (D):									
Raw	3	[3] 73.6	[3] 2.6	--	3.6	--	--	--	11.7
Oven-braised at 300° in 30 ml. water for 38 minutes to 176°		58.3	5.3	--	5.5	--	--	--	10.5
Pressure-braised at 10 pounds in 20 ml. water for 12 minutes to 176°.		57.2	5.7	--	5.7	--	--	--	10.3

See footnotes at end of table.

TABLE 39. --Effect of cooking method on the chemical composition of steer beef of Good grade and below--Continued

Description of beef, station code,[1] and cooking method (° F.)	Animals	Moisture	Fat[2]		Nitrogen			Collagen	
			Moist basis	Dry basis	Moist basis	Dry basis	Dry-fat-free basis	Moist basis	Percent of total N
Bottom round:--Continued									
Commercial:--Continued									
Roasts, biceps femoris (C):	*Number*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Raw	4	74.2	--	11.7	3.1	12.6	--	0.09	2.98
Oven-braised at 300° for 129 minutes to 158°		62.8	--	11.7	4.1	12.0	--	.03	.65
Oven-braised at 300° for 166 minutes to 194°		61.7	--	11.6	4.8	12.7	--	.01	.21
1-1/2-inch-thick cuts, semitendinosus (A):									
Raw	2	70.2	8.2	27.2	3.3	--	--	1.02	4.9
Oven-braised at 300° for 68 minutes to 185°		54.7	16.0	35.1	4.6	--	--	.84	2.9
Pressure-braised at 5 pounds for 35 minutes to 185°		56.4	11.7	26.4	5.1	--	--	.75	2.4
Pressure-braised at 10 pounds for 36 minutes to 185°		52.6	14.8	29.8	5.2	--	--	.37	1.1
Pressure-braised at 15 pounds for 36 minutes to 185°		55.8	11.0	24.4	5.3	--	--	.53	1.6
1-1/2-inch-thick cuts, semitendinosus (A):									
Raw	2	69.2	9.2	29.8	3.3	--	--	--	5.1
Oven-braised at 300° for 70 minutes to 185°		51.4	19.3	39.6	4.7	--	--	.49	1.7
Roasted at 250° for 425 minutes to 185°		53.1	16.1	34.4	5.0	--	--	.52	1.7
Roasted at 300° for 124 minutes to 185°		55.1	17.4	38.6	4.4	--	--	.56	2.1
3-inch-thick cuts, semitendinosus (B):									
Raw	4	70.5	7.7	25.4	3.3	11.4	--	--	--
Oven-braised at 300° for 78 minutes to 176°		58.0	10.9	25.9	4.7	11.5	--	--	--
Range-braised at 300° for 73 minutes to 176°		59.4	9.9	24.3	4.7	11.6	--	--	--
3-inch-thick cuts, semitendinosus (B):									
Raw	2	70.8	7.1	24.2	3.5	12.1	--	--	--
Oven-braised at 300° for 87 minutes to 176°		56.3	13.9	31.6	4.3	9.9	--	--	--
Roasted at 300° for 121 minutes to 176°		58.7	11.3	27.2	4.8	11.6	--	--	--
Roasts, semitendinosus (C):									
Raw	4	74.1	--	8.1	3.2	13.7	--	.10	2.96
Oven-braised at 300° for 89 minutes to 158°		64.6	--	9.2	4.4	12.3	--	.04	.82
Oven-braised at 300° for 131 minuts to 194°		61.8	--	9.5	5.1	13.6	--	.02	.29
Utility:									
3/4-inch-thick cuts (G):									
Raw	1	70.0	8.8	29.2	3.2	10.5	14.9	--	--
Range-braised at 212° for 45 minutes in 1 cup water		53.8	12.5	27.0	5.1	11.0	15.1	--	--
Broiled, well-done, for 35 minutes		54.2	11.3	24.5	5.1	11.2	14.9	--	--
2-1/2-inch-thick cuts (G):									
Raw	1	70.8	8.8	29.0	3.2	11.2	15.7	--	--
Range-braised at 212° for 78 minutes to 208°		56.1	14.3	32.6	4.6	10.5	15.5	--	--
Roasted at 302° for 209 minutes to 176°		57.7	10.2	24.1	5.1	12.0	15.8	--	--
Chuck:									
Good:									
2-1/2-inch-thick cuts (G):									
Raw	1	67.2	14.5	44.0	2.9	8.8	15.8	--	--
Range-braised at 212° for 78 minutes to 199°		57.1	13.6	31.7	4.3	10.1	14.8	--	--
Roasted at 302° for 173 minutes to 176°		58.6	14.0	33.8	4.2	10.1	15.2	--	--

Commercial:									
3-inch-thick inside cuts (D):									
Raw	6	72.6	5.8	--	3.2	--	--	--	11.2
Oven-braised in 30 ml. water at 300° for 129 minutes		54.9	12.8	--	4.8	--	--	--	11.6
Pressure-braised in 20 ml. water at 10 pounds for 57 minutes for 15 minutes per inch of thickness		56.3	12.0	--	4.9	--	--	--	11.8
3-inch-thick outside cuts (D):									
Raw	6	73.7	4.1	--	3.3	--	--	--	10.4
Oven-braised in 30 ml. water at 300° for 137 minutes		57.4	9.9	--	4.9	--	--	--	11.8
Pressure-braised in 20 ml. water at 10 pounds for 54 minutes for 15 minutes per inch of thickness		57.8	8.2	--	5.0	--	--	--	11.3
Utility:									
3/4-inch-thick cuts (G):									
Raw	1	71.7	7.6	26.3	3.1	11.0	14.9	--	--
Range-braised at 212° in 1 cup water for 45 minutes		55.6	11.5	25.3	5.1	11.5	15.4	--	--
Broiled, well-done, for 34 minutes		54.4	11.7	24.7	5.3	11.4	15.2	--	--
2-1/2-inch-thick cuts (G):									
Raw	1	74.2	5.6	21.4	3.1	12.1	15.4	--	--
Range-braised at 212° for 58 minutes to 199°		61.7	7.6	19.8	4.8	12.4	15.5	--	--
Roasted at 302° for 245 minutes to 176°		56.6	10.7	24.7	4.9	11.4	15.1	--	--
Loin:									
Good:									
2-1/2-inch-thick cuts (G):									
Raw	1	51.1	33.4	68.2	2.4	4.9	15.3	--	--
Range-braised at 212° for 74 minutes to 199°		38.4	42.7	69.3	2.9	4.8	15.6	--	--
Roasted at 302° for 234 minutes to 176°		34.7	43.0	65.8	3.4	5.2	15.2	--	--
Roasts, longissimus dorsi (C):									
Raw	2	74.4	--	11.2	3.6	13.7	--	0.07	1.84
Roasted at 300° for 126 minutes to 158°		66.7	--	12.2	4.9	12.0	--	.01	.22
Roasted at 300° for 232 minutes to 194°		61.3	--	16.1	4.6	12.2	--	.02	.37
Roasts, psoas major (C):									
Raw	2	73.1	--	19.6	3.4	12.9	--	.03	.96
Roasted at 300° for 120 minutes to 158°		67.4	--	22.2	3.9	11.2	--	.01	.37
Roasted at 300° for 240 minutes to 194°		58.8	--	23.1	4.8	10.9	--	.01	.16
Commercial:									
2-inch-thick cuts (D):									
Raw	6	72.2	4.4	--	3.4	--	--	--	9.2
Oven-braised at 300° for 87 minutes to 176°		58.4	8.4	--	5.0	--	--	--	10.2
Broiled for 90 minutes to 176°		55.8	8.6	--	5.3	--	--	--	9.5
Roasts, longissimus dorsi (C):									
Raw	4	74.5	--	10.6	3.4	14.2	--	.06	1.64
Roasted at 300° for 174 minutes to 158°		66.1	--	12.7	4.2	12.6	--	.02	.38
Roasted at 300° for 272 minutes to 194°		62.6	--	12.3	4.8	13.7	--	.01	.13
Roasts, psoas major (C):									
Raw	4	74.4	--	15.3	3.2	12.3	--	.03	1.04
Roasted at 300° for 160 minutes to 158°		68.0	--	16.7	3.6	11.4	--	.01	.28
Roasted at 300° for 240 minutes to 194°		62.9	--	18.4	4.2	11.8	--	.01	.23

See footnotes at end of table.

TABLE 39. --Effect of cooking method on the chemical composition of steer beef of Good grade and below--Continued

Description of beef, station code,[1] and cooking method (° F.)	Animals	Moisture	Fat[2]		Nitrogen			Collagen	
			Moist basis	Dry basis	Moist basis	Dry basis	Dry-fat-free basis	Moist basis	Percent of total N
Loin--Continued									
Utility:									
3/4-inch-thick cuts (G):	*Number*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
Raw	1	64.8	16.8	48.3	2.7	7.6	14.8	--	--
Range-braised at 212°. in 1 cup water for 45 minutes		46.6	28.2	52.7	3.9	7.3	15.4	--	--
Broiled, well-done, for 35 minutes		49.6	20.6	40.4	4.4	8.7	14.6	--	--
3-inch-thick cuts (G):									
Raw	1	62.4	20.6	53.2	2.6	7.1	15.1	--	--
Range-braised at 212° for 76 minutes to 199°		55.8	17.2	38.9	4.2	9.5	15.5	--	--
Roasted at 302° for 203 minutes to 176°		48.1	27.7	53.4	3.8	7.4	15.9	--	--
Rib:									
Good:									
Roasts, longissimus dorsi (C):									
Raw	2	74.6	--	12.7	3.3	13.6	--	0.06	1.78
Roasted at 300° for 214 minutes to 158°		67.8	--	10.8	4.1	11.8	--	.02	.55
Roasted at 300° for 258 minutes to 194°		62.9	--	10.8	4.6	11.8	--	.02	.27
Commercial:									
Roasts, longissimus dorsi (C):									
Raw	4	74.8	--	11.1	3.3	13.1	--	.05	1.51
Roasted at 300° for 252 minutes to 158°		65.3	--	11.7	4.1	12.1	--	.02	.55
Roasted at 300° for 364 minutes to 194°		60.9	--	13.2	4.8	12.7	--	.01	.30
3-rib-cuts (D):									
Raw	6	72.6	4.7	--	3.5	--	--	--	8.8
Oven-braised at 300° for 273 minutes to 176° without added liquid		58.2	10.4	--	4.8	--	--	--	9.8
Roasted at 300° for 309 minutes to 176°		60.4	9.2	--	4.5	--	--	--	9.8
Utility:									
2-1/2 and 3-inch-thick cuts (G):									
Raw	2	69.9	10.5	34.7	3.0	9.9	15.2	--	--
Range-braised at 212° in 1 cup water for 77 minutes to 199°		56.4	18.2	41.4	3.9	8.9	15.1	--	--
Roasted at 302° for 206 minutes to 176°		54.8	15.5	33.9	4.5	9.9	15.0	--	--

[1] See table 30, footnote 1, page 48.

[2] Samples for fat analyses: Samples from Stations A and B not trimmed of exterior fat; from Station G partially trimmed; from Station C, D, and F trimmed of fat.

[3] Data for two animals only.

[4] Data for one animal only.

TABLE 40.--Effect of cooking method on the chemical composition of dairy cow beef of Good grade and below (station F[1])

Description of beef,[2] method of thawing and cooking[3]	Animals	Moisture	Fat, moist basis	Nitrogen	
				Moist basis	Dry fa free bas
Top round:					
Commercial:					
Refrigerator-thawed:	*Number*	*Percent*	*Percent*	*Percent*	*Percent*
Raw..	1	73.4	1.0	4.0	14.7
Oven-braised for 134 minutes......................		57.6	4.0	5.8	15.1
Pressure-braised in 59 ml. water for 100 minutes...		55.8	3.0	6.2	15.1
Cooking-thawed:					
Raw..	1	74.2	.7	3.9	15.5
Oven-braised in 30 ml. water for 182 minutes.......		56.8	7.0	5.5	15.2
Pressure-braised in 178 ml. water for 140 minutes..		57.3	4.0	5.9	15.3
Utility:					
Unfrozen:					
Raw..	3	70.8	6.3	3.4	15.2
Oven-braised for 153 minutes......................		60.3	4.7	5.9	17.2
Pressure-braised in 59 ml. water for 104 minutes...		57.6	4.3	5.7	15.1
Refrigerator-thawed:					
Raw..	1	71.0	3.5	3.8	14.7
Oven-braised for 142 minutes......................		55.7	7.0	5.4	14.5
Pressure-braised in 59 ml. water for 122 minutes...		53.0	6.0	6.1	14.9
Cooking-thawed:					
Raw..	4	[4] 72.5	[4] 2.5	[4] 4.0	[4] 16.2
Oven-braised in 30 ml. water for 208 minutes.......		56.8	9.0	5.8	[5] 15.5
Pressure-braised in 178 ml. water for 137 minutes..		56.2	4.0	5.8	[5] 14.5
Cutter:					
Unfrozen:					
Raw..	1	74.0	1.0	2.7	10.8
Oven-braised for 207 minutes......................		56.5	1.0	6.3	14.8
Pressure-braised in 59 ml. water for 110 minutes		55.5	1.0	6.9	15.9
Cooking-thawed:					
Raw..	1	73.8	--	3.8	13.8
Oven-braised in 30 ml. water for 232 minutes.......		57.5	2.0	6.0	14.8
Pressure-braised in 178 ml. water for 81 minutes...		54.4	2.0	5.5	12.6
Bottom round:					
Commercial:					
Refrigerator-thawed:					
Raw..	1	72.6	2.0	3.9	15.0
Oven-braised for 147 minutes......................		55.9	9.0	5.4	15.4
Pressure-braised in 59 ml. water for 115 minutes...		55.1	7.0	5.8	15.3
Cooking-thawed:					
Raw..	1	73.6	2.0	3.8	15.6
Oven-braised in 30 ml. water for 216 minutes.......		56.0	5.0	6.1	15.6
Pressure-braised in 59 ml. water for 82 minutes....		56.2	5.0	5.7	14.7
Utility:					
Unfrozen:					
Raw..	3	71.4	4.5	4.0	16.8
Oven-braised for 159 minutes......................		59.1	10.0	5.4	21.1
Pressure-braised in 59 ml. water for 127 minutes...		60.2	7.3	5.7	18.5
Refrigerator-thawed:					
Raw..	1	71.6	3.0	3.8	14.8
Oven-braised for 174 minutes......................		53.7	8.0	5.3	13.8
Pressure-braised in 59 ml. water for 128 minutes...		52.3	8.0	5.5	13.9
Cooking-thawed:					
Raw..	4	[4] 72.8	[4] 2.5	[4] 3.7	[4] 15.2
Oven-braised in 30 ml. water for 233 minutes.......		54.2	7.8	5.5	[5] 14.2
Pressure-braised in 178 ml. water for 132 minutes..		55.0	7.2	5.7	[5] 14.9
Cutter:					
Unfrozen:					
Raw..	1	74.8	1.0	3.0	12.6
Oven-braised for 177 minutes......................		55.9	3.0	6.2	15.1
Pressure-braised in 59 ml. water for 121 minutes...		54.3	3.0	6.7	15.7
Cooking-thawed:					
Raw..	1	72.8	--	3.6	15.4
Oven-braised in 30 ml. water for 222 minutes.......		56.7	3.0	6.2	15.4
Pressure-braised in 178 ml. water for 131 minutes..		54.4	6.0	6.7	15.7

See footnotes at end of table.

TABLE 40.--Effect of cooking method on the chemical composition of dairy cow beef of Good grade and below (station F[1])--Continued

Description of beef,[2] method of thawing and cooking[3]	Animals	Moisture	Fat, moist basis	Nitrogen	
				Moist basis	Dry fat-free basis
Chuck:					
Commercial:					
Refrigerator-thawed:	*Number*	*Percent*	*Percent*	*Percent*	*Percent*
Raw	1	71.2	6.0	3.5	15.4
Oven-braised for 112 minutes		55.1	10.0	5.2	14.9
Pressure-braised in 59 ml. water for 133 minutes		49.2	13.0	5.3	14.0
Cooking-thawed:					
Raw	1	72.2	4.5	3.6	15.4
Oven-braised in 30 ml. water for 164 minutes		53.8	12.0	5.2	15.2
Pressure-braised in 178 ml. water for 102 minutes		52.5	13.0	5.2	15.0
Utility:					
Unfrozen:					
Raw	3	70.3	8.5	3.1	16.0
Oven-braised for 157 minutes		55.4	9.3	5.4	15.2
Pressure-braised in 59 ml. water for 96 minutes		57.9	8.3	5.5	16.3
Refrigerator-thawed:					
Raw	1	71.0	6.0	3.7	16.2
Oven-braised for 159 minutes		51.7	7.0	4.9	11.9
Pressure-braised in 59 ml. water for 86 minutes		55.7	6.0	5.6	14.6
Cooking-thawed:					
Raw	4	[4] 71.5	[4] 5.8	[4] 3.4	[4] 14.7
Over-braised in 30 ml. water for 206 minutes		54.8	9.2	5.2	[5] 14.1
Pressure-braised in 178 ml. water for 116 minutes		51.4	10.2	5.7	[5] 15.9
Cutter:					
Unfrozen:					
Raw	1	69.8	9.5	3.0	14.3
Oven-braised for 121 minutes		55.1	5.0	5.9	14.8
Pressure-braised in 59 ml. water for 82 minutes		53.9	8.0	5.7	15.0
Cooking-thawed:					
Raw	1	71.6	--	3.4	16.4
Oven-braised in 30 ml. water for 157 minutes		57.5	7.0	5.4	15.2
Pressure-braised in 178 ml. water for 119 minutes		55.9	6.0	6.1	16.0

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[1] See table 30, footnote 1, page 48.

[2] Each cut weighed approximately 4 pounds.

[3] Oven-braising was done at 300° F. to an end-point temperature of 209°; pressure-braising was done at 10 pounds to 216°.

[4] Data for 2 animals only.

[5] Data for 3 animals only.

TABLE 41.--Effect of cooking method on nitrogen, thiamine, riboflavin, pantothenic acid, and niacin content of steer beef of Good grade and below

Description of beef, station code,[1] and cooking method (°F.)	Animals	Vitamin content, moist basis				Vitamin content, dry fat-free basis				Nitrogen, moist basis
		Thiamine	Ribo-flavin	Panto-thenic acid	Niacin	Thiamine	Ribo-flavin	Panto-thenic acid	Niacin	
Top round:										
Good:										
1-1/2-inch-thick cuts, semimembranosus (B):	*Number*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Percent*
Raw	2	0.19	0.13	--	--	0.90	0.61	--	--	3.3
Oven-braised at 350° for 50 minutes to 176°	2	.18	.18	--	--	.56	.43	--	--	5.1
Roasted at 350° for 82 minutes to 176°	2	.21	.14	--	--	.64	.54	--	--	4.8
2-1/2-inch-thick cuts (G):										
Raw	1	.08	.19	0.35	3.7	.43	.98	1.84	19.7	2.8
Range-braised at 212° in 1 cup water for 102 minutes to 208°, after browning	1	.04	.17	.19	3.0	.17	.65	.73	11.8	3.9
Roasted at 302° for 243 minutes to 176°	1	.07	.23	.45	5.2	.22	.71	1.42	16.3	4.6
3-inch-thick cuts, semimembranosus (B):										
Raw	2	.19	.13	--	--	.90	.61	--	--	3.3
Oven-braised at 300° for 86 minutes to 176°	2	.24	.15	--	--	.74	.48	--	--	4.7
Roasted at 300° for 160 minutes to 176°	2	.27	.16	--	--	.88	.52	--	--	4.6
Commercial:										
1-1/2-inch-thick cuts, semimembranosus (B):										
Raw	6	.17	.11	--	--	.78	.50	--	--	3.3
Oven-braised at 350° for 53 minutes to 176°	6	.20	.17	--	--	.54	.46	--	--	5.5
Roasted at 350° for 128 minutes to 176°	6	.21	.19	--	--	.55	.51	--	--	5.8
3-inch-thick cuts, semimembranosus (B):										
Raw	6	.17	.11	--	--	.78	.50	--	--	3.3
Oven-braised at 300° for 124 minutes to 176°	6	.19	.18	--	--	.53	.50	--	--	5.5
Roasted at 300° for 198 minutes to 176°	6	.19	.19	--	--	.55	.53	--	--	5.3
Utility:										
3/4-inch-thick cuts (G):										
Raw	1	.07	.16	.24	3.6	.33	.83	1.20	18.0	2.9
Range-braised at 212° in 1 cup water for 45 minutes, after browning	1	.04	.16	.17	3.1	.13	.50	.53	9.4	5.1
Broiled for 37 minutes, until well done	1	.08	.20	.20	4.6	.23	.59	.61	13.8	5.1
2-1/2-inch-thick cuts (G):										
Raw	1	.08	.18	.22	4.3	.39	.90	1.08	21.0	3.1
Range-braised at 212° in 1 cup water for 62 minutes to 208°, after browning	1	.06	.17	.14	3.5	.18	.54	.44	11.4	4.6
Roasted at 302° for 325 minutes to 176°	1	.07	.24	.27	6.4	.18	.67	.75	17.6	5.5
Bottom round:										
Good:										
1-1/2-inch-thick cuts, biceps femoris (B):										
Raw	2	.24	.10	--	--	1.20	.48	--	--	3.2
Oven-braised at 350° for 38 minutes to 176°	2	.21	.16	--	--	.71	.49	--	--	5.1
Roasted at 350° for 98 minutes to 176°	2	.18	.18	--	--	.46	.43	--	--	6.2
2-1/2-inch-thick cuts (G):										
Raw	1	.07	.18	.29	3.5	.38	.95	1.53	18.3	2.9
Range-braised at 212° in 1 cup water for 99 minutes to 208°, after browning	1	.04	.16	.17	2.8	.16	.62	.66	11.1	3.9
Roasted at 302° for 212 minutes to 176°	1	.08	.21	.34	4.2	.25	.68	1.12	13.8	4.7
3-inch-thick cuts, semitendinosus (B):										
Raw	2	.22	.09	--	--	1.07	.41	--	--	3.3

TABLE 41.--Effect of cooking method on nitrogen, thiamine, riboflavin, pantothenic acid, and niacin content of steer beef of Good grade and below--Continued

Description of beef, station code,[1] and cooking method (°F.)	Animals	Vitamin content, moist basis				Vitamin content, dry fat-free basis				Nitrogen, moist basis
		Thiamine	Ribo-flavin	Panto-thenic acid	Niacin	Thiamine	Ribo-flavin	Panto-thenic acid	Niacin	
Bottom round (cont'd):										
Commercial:										
1-1/2-inch-thick cuts, biceps femoris (B):	*Number*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Percent*
Raw	4	0.20	0.14	--	--	0.90	0.62	--	--	3.2
Range-braised for 60 minutes in 50 ml. water to 176°, after browning	4	.16	.16	--	--	.51	.54	--	--	4.8
Broiled at approximately 350° for 94 minutes to 176°	4	.14	.20	--	--	.43	.60	--	--	5.2
1-1/2-inch-thick cuts, biceps femoris (B):										
Raw	2	.15	.19	--	--	.68	.87	--	--	3.3
Oven-braised at 350° for 60 minutes to 176° without browning	2	.16	.26	--	--	.48	.77	--	--	4.9
Roasted at 350° for 132 minutes to 176°	2	.16	.30	--	--	.43	.81	--	--	6.0
3-inch-thick cuts, semitendinosus (B):										
Raw	4	.14	.08	--	--	.66	.39	--	--	3.3
Oven-braised at 300° for 78 minutes to 176°	4	.22	.14	--	--	.68	.46	--	--	4.7
Range-braised at 300° for 73 minutes to 176°	4	.21	.11	--	--	.66	.36	--	--	4.7
3-inch-thick cuts, semitendinosus (B):										
Raw	2	.13	.12	--	--	.58	.57	--	--	3.5
Oven-braised at 300° for 87 minutes to 176°	2	.13	.18	--	--	.44	.59	--	--	4.3
Roasted at 300° for 121 minutes to 176°	2	.15	.19	--	--	.48	.64	--	--	4.8
Utility:										
3/4-inch-thick cuts (G):										
Raw	1	.09	.17	0.28	4.2	.43	.83	1.37	18.0	3.2
Range-braised at 212° in 1 cup water for 45 minutes, after browning	1	.07	.18	.17	3.4	.19	.51	.51	9.9	5.1
Broiled for 35 minutes, until well done	1	.10	.19	.26	4.3	.28	.55	.70	14.5	5.1
2-1/2-inch-thick cuts (G):										
Raw	1	.08	.18	.20	4.0	.40	.86	.96	19.6	3.2
Range-braised at 212° in 1 cup water for 78 minutes to 208°, after browning	1	.04	.15	.09	3.4	.15	.51	.31	11.4	4.6
Roasted at 302° for 209 minutes to 176°	1	.06	.20	.19	5.4	.19	.62	.60	16.9	5.1
Chuck:										
Good:										
2-1/2-inch-thick cuts (G):										
Raw	1	.09	.19	.42	3.6	.47	1.04	2.19	18.8	2.9
Range-braised at 212° in 1 cup water for 78 minutes to 199°, after browning	1	.06	.18	.28	2.3	.21	.63	.94	9.7	4.3
Roasted at 302° for 173 minutes to 176°	1	.07	.19	.40	3.8	.24	.70	1.43	13.7	4.2
Utility:										
3/4-inch-thick cuts (G):										
Raw	1	.10	.23	.31	3.9	.46	1.26	1.48	19.0	3.1
Range-braised at 212° in 1 cup water for 45 minutes, after browning	1	.08	.21	.29	3.1	.25	.65	.88	9.4	5.1
Broiled for 34 minutes, until well done	1	.05	.27	.18	2.6	.14	.62	.52	7.8	5.3
2-1/2-inch-thick cuts (G):										
Raw	1	.08	.22	.30	3.7	.42	1.09	1.49	18.2	3.1
Range-braised at 212° in 1 cup water for 58 minutes to 199°, after browning	1	.05	.21	.20	3.4	.17	.68	.66	11.0	4.8
Roasted at 302° for 245 minutes to 176°	1	.06	.25	.32	4.6	.18	.77	.97	14.1	4.9

Loin:									
Good:									
2-1/2-inch-thick cuts (G):									
Raw	1	0.07	0.15	0.28	2.8	0.45	0.98	1.83	18.2	2.4
Range-braised at 212° in 1 cup water for 74 minutes to 199°, after browning	1	.04	.13	.20	2.4	.23	.70	1.06	12.5	2.9
Roasted at 302° for 234 minutes to 176°	1	.05	.20	.36	3.0	.21	.88	1.61	13.4	3.4
Utility:									
3/4-inch-thick cuts (G):									
Raw	1	.08	.15	.25	4.3	.42	.84	1.34	23.1	2.7
Range-braised at 212° in 1 cup water for 45 minutes to 199°, after browning	1	.04	.15	.15	2.9	.17	.58	.60	11.5	3.9
Broiled for 35 minutes, until well done	1	.08	.17	.20	5.6	.27	.56	.68	18.5	4.4
3-inch-thick cuts (G):									
Raw	1	.06	.14	.12	4.4	.39	.82	.73	25.6	2.6
Range-braised at 212° in 1 cup water for 76 minutes to 199°, after browning	1	.05	.18	.19	4.4	.17	.66	.69	16.4	4.2
Roasted at 302° for 203 minutes to 176°	1	.04	.18	.22	5.1	.17	.76	.93	21.0	3.8
Rib:									
Good:									
2-1/2-inch-thick cuts (G):									
Raw	1	.06	.14	.26	3.3	.41	.92	1.68	21.6	2.4
Range-braised at 212° in 1 cup water for 69 minutes to 199°, after browning	1	.04	.13	.18	2.4	.21	.66	.88	12.6	3.0
Roasted at 302° for 165 minutes to 176°	1	.04	.15	.24	4.4	.15	.65	.97	18.0	3.6
Utility:									
2-1/2- and 3-inch-thick cuts (G):									
Raw	2	.07	.18	.24	3.8	.34	.90	1.24	19.1	3.0
Range-braised at 212° in 1 cup water for 77 minutes to 199°, after browning	2	.04	.16	.18	2.9	.18	.62	.72	11.5	3.9
Roasted at 302° for 206 minutes to 176°	2	.05	.21	.29	4.7	.17	.72	.98	15.8	4.5

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[1] See table 30, footnote 1, page 48.

TABLE 42.--Effect of cooking method on the thiamine and riboflavin content of dairy cow beef of Good grade and below (station F)[1]

Description of beef[2], method of thawing and cooking[3]	Animals	Vitamin content, moist basis		Vitamin content, dry fat-free basis		Nitrogen, moist basis
		Thiamine	Ribo-flavin	Thiamine	Ribo-flavin	
Top round:						
Commercial:						
Refrigerator-thawed:	*Number*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Percent*
Raw	1	0.07	0.42	0.29	1.64	4.0
Oven-braised for 134 minutes	1	.03	.32	.07	.83	5.8
Pressure-braised in 59 ml. water for 100 minutes	1	.04	.56	.09	1.36	6.2
Cooking-thawed:						
Raw	1	.07	.40	.25	1.54	3.9
Oven-braised in 30 ml. water for 182 minutes	1	.03	.32	.08	.88	5.5
Pressure-braised in 178 ml. water for 140 minutes	1	.03	.63	.09	1.64	5.9
Utility:						
Unfrozen:						
Raw	3	.06	.18	.24	.61	3.4
Oven-braised for 153 minutes	3	.04	.19	.10	.49	5.9
Pressure-braised in 59 ml. water for 104 minutes	3	.04	.22	.11	.62	5.7
Refrigerator-thawed:						
Raw	1	.08	.38	.32	1.46	3.8
Oven-braised for 142 minutes	1	.05	.24	.28	.65	5.4
Pressure-braised in 59 ml. water for 122 minutes	1	.04	.25	.09	.61	6.1
Cooking-thawed:						
Raw	4	.06	.28	[4] .26	[4] 1.19	[4] 4.0
Oven-braised in 30 ml. water for 208 minutes	4	.04	.29	[5] .12	[5] .86	[5] 5.8
Pressure-braised in 178 ml. water for 137 minutes	4	.03	.29	[5] .07	[5] .75	[5] 5.8
Cutter:						
Unfrozen:						
Raw	1	.07	.26	.26	1.05	2.7
Oven-braised for 207 minutes	1	.04	.13	.10	.30	6.3
Pressure-braised in 59 ml. water for 110 minutes	1	.02	.14	.05	.33	6.9
Cooking-thawed:						
Raw	1	.05	.38	.26	1.05	3.8
Oven-braised in 30 ml. water for 232 minutes	1	.03	.24	.08	.60	6.0
Pressure-braised in 178 ml. water for 81 minutes	1	.04	.27	.09	.62	5.5
Bottom round:						
Commercial:						
Refrigerator-thawed:						
Raw	1	.07	.43	.29	1.68	3.9
Oven-braised for 147 minutes	1	.04	.54	.12	1.43	5.4
Pressure-braised in 59 ml. water for 115 minutes	1	.04	.29	.09	.83	5.8
Cooking-thawed:						
Raw	1	.07	.42	.30	1.72	3.8
Oven-braised in 30 ml. water for 216 minutes	1	.04	.41	.09	1.05	6.1
Pressure-braised in 178 ml. water for 82 minutes	1	.03	.32	.09	.83	5.7
Utility:						
Unfrozen:						
Raw	3	.06	.19	.23	.57	4.0
Oven-braised for 159 minutes	3	.04	.19	.14	.69	5.4
Pressure-braised in 59 ml. water for 127 minutes	3	.03	.20	.10	.64	5.7
Refrigerator-thawed:						
Raw	1	.08	.38	.33	1.51	3.8
Oven-braised for 174 minutes	1	.06	.20	.34	.61	5.3
Pressure-braised in 59 ml. water for 128 minutes	1	.03	.28	.08	.51	5.5
Cooking-thawed:						
Raw	4	.06	.27	[4] .27	[4] 1.11	[4] 3.7
Oven-braised in 30 ml. water for 233 minutes	4	.04	.30	[5] .10	[5] .80	[5] 5.5
Pressure-braised in 178 ml. water for 132 minutes	4	.03	.39	[5] .08	[5] 1.03	[5] 5.7
Cutter:						
Unfrozen:						
Raw	1	.05	.28	.22	1.16	3.0
Oven-braised for 177 minutes	1	.04	.15	.09	.36	6.2
Pressure-braised in 59 ml. water for 121 minutes	1	.03	.17	.08	.40	6.7
Cooking-thawed:						
Raw	1	.06	.41	.22	1.16	3.6
Oven-braised in 30 ml. water for 222 minutes	1	.04	.22	.11	.56	6.2
Pressure-braised in 178 ml. water for 131 minutes	1	.04	.27	.09	.68	6.7

See footnotes at end of table.

TABLE 42.--Effect of cooking method on the thiamine and riboflavin content of dairy cow beef of Good grade and below (station F)[1]--(Continued)

Description of beef[2], method of thawing and cooking[3]	Animals	Vitamin content, moist basis		Vitamin content, dry fat-free basis		Nitrogen, moist basis
		Thiamine	Ribo-flavin	Thiamine	Ribo-flavin	
Chuck:						
Commercial:						
Refrigerator-thawed:	*Number*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Mg./100 gm.*	*Percent*
Raw	1	0.07	0.47	0.31	2.08	3.5
Oven-braised for 112 minutes	1	.04	.34	.11	.97	5.2
Pressure-braised in 59 ml. water for 133 minutes	1	.03	.57	.09	1.50	5.3
Cooking-thawed:						
Raw	1	.07	.49	.30	2.10	3.6
Oven-braised in 30 ml. water for 164 minutes	1	.02	.42	.07	1.23	5.2
Pressure-braised in 178 ml. water for 102 minutes	1	.03	.70	.06	2.02	5.2
Utility:						
Unfrozen:						
Raw	3	.05	.21	.25	.69	3.1
Oven-braised for 157 minutes	3	.03	.21	.07	.59	5.4
Pressure-braised in 59 ml. water for 96 minutes	3	.02	.25	.06	.74	5.5
Refrigerator-thawed:						
Raw	1	.07	.41	.32	1.79	3.7
Oven-braised for 159 minutes	1	.04	.27	.31	.65	4.9
Pressure-braised in 59 ml. water for 86 minutes	1	.03	.24	.09	.63	5.6
Cooking-thawed:						
Raw	4	.06	.29	[4] .28	[4] 1.37	[4] 3.4
Oven-braised in 30 ml. water for 206 minutes	4	.03	.30	[5] .10	[5] .88	[5] 5.2
Pressure-braised in 178 ml. water for 116 minutes	4	.02	.38	[5] .05	[5] 1.03	[5] 5.7
Cutter:						
Unfrozen:						
Raw	1	.04	.21	.19	1.01	3.0
Oven-braised for 121 minutes	1	.02	.17	.05	.42	5.9
Pressure-braised in 59 ml. water for 82 minutes	1	.03	.21	.08	.55	5.7
Cooking-thawed:						
Raw	1	.06	.45	.19	1.01	3.4
Oven-braised in 30 ml. water for 157 minutes	1	.03	.32	.10	.91	5.4
Pressure-braised in 178 ml. water for 119 minutes	1	.02	.34	.06	.80	6.1

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[1] See table 30, footnote 1, page 48.
[2] Each cut weighed approximately 4 pounds.
[3] Oven-braising was done at 300° F. to an end-point temperature of 209° ; pressure-braising was done at 10 pounds to 216°.
[4] Data for 2 animals only.
[5] Data for 3 animals only.

TABLE 43.--Cooking time, shrinkage, and yield of cooked meat as related to cooking method, moisture, and fat content of beef of Good grade and below

Description of beef, station code,[1] and cooking method (°F.)	Cuts	Weight of cut	Moisture content		Fat content, moist basis		Cooking time		End-point temperature	Cooking shrinkage		Yield of cooked cut[3]
			Raw	Cooked	Raw	Cooked	Total	Per pound		Total[2]	Drippings	
TOP ROUND												
Steer:	*Number*	*Pounds*	*Percent*	*Percent*	*Percent*	*Percent*	*Minutes*	*Minutes*	°F.	*Percent*	*Percent*	*Percent*
3/4-inch-thick cuts (G):												
Range-braised at 212° in 1 cup water, after browning..	2	0.98	68.3	53.9	11.8	13.1	45.0	48.0	--	43.0	--	57.0
Broiled, well done..................................	2	1.04		53.7		13.0	37.0	36.0	--	46.0	--	54.0
1-1/2-inch-thick cuts (A):												
Oven-braised at 300° in 30 ml. water, after browning..	2	1.56	68.6	54.6	10.6	14.0	60.0	38.4	185°	32.9	19.2	67.1
Roasted at 250°	2	1.45		47.7		16.8	420.0	321.1	185°	39.8	3.6	60.2
Roasted at 300°....................................	2	1.83		56.8		13.0	95.0	50.5	185°	30.0	7.5	70.0
1-1/2-inch-thick cuts (A):												
Oven-braised at 300° in 30 ml. water after browning...	2	2.00	69.4	47.5	9.1	24.4	65.0	32.5	185°	30.6	19.2	69.4
Pressure-braised at 5 pounds (227.1°) in 30 ml. water, after browning............................	2	2.54		56.1		12.0	36.5	14.4	185°	31.9	24.0	66.1
Pressure-braised at 10 pounds (240°) in 30 ml. water, after browning............................	2	2.47		51.8		14.4	32.0	12.9	185°	38.2	24.4	61.8
Pressure-braised at 15 pounds (250°) in 30 ml. water, after browning............................	2	2.84		52.8		15.6	40.0	14.0	185°	34.4	25.4	65.6
1-1/2-inch-thick cuts (D):												
Oven-braised at 300° in 30 ml. water, after browning..	12	2.46	73.9	57.8	1.9	5.3	49.9	20.3	176°	33.6	--	66.4
Pressure-braised at 10 pounds (240°) in 20 ml. water, after browning............................	12	2.40		58.2		4.3	11.8	4.9	176°	33.3	--	66.7
1-1/2-inch-thick cuts, semimembranosus (B):												
Oven-braised at 350° without browning or liquid.......	16	.82	72.1	57.9	6.5	6.7	50.1	61.0	176°	38.4	21.4	61.6
Roasted at 350°....................................	16	.80	72.6	56.5	5.6	6.4	115.6	144.0	176°	42.3	2.9	57.7
2-1/2-inch-thick cuts (G):												
Range-braised at 212° in 1 cup water, after browning..	6	3.18	66.4	52.2	14.0	19.6	98.0	31.0	208°	38.0	--	62.0
Roasted at 302°....................................	6	3.28		54.2		11.7	299.0	93.0	176°	43.0	--	57.0
3-inch-thick cuts, semimembranosus (B):												
Oven-braised at 300° without browning or liquid.......	16	1.89	72.1	59.2	6.5	6.6	110.6	59.0	176°	39.0	28.5	61.0
Roasted at 300°....................................	16	1.85	72.6	59.6	5.6	6.4	188.5	102.0	176°	36.5	7.2	63.5
Cow:												
1-inch-thick cuts, semimembranosus (E):												
Oven-braised at 250° in 50 ml. water, after browning..	30	.93	--	--	--	--	25.7	27.6	176°	33.1	--	66.9
Roasted (oven-broiled) at 450°.......................	30	.90	--	--	--	--	17.3	19.2	160°	26.6	--	73.4
1-inch-thick cuts, adductor (E):												
Oven-braised at 250° in 50 ml. water, after browning..	18	.50	--	--	--	--	18.6	37.2	176°	36.4	--	63.6
Roasted (oven-broiled) at 450°.......................	18	.50	--	--	--	--	13.2	26.4	160°	27.2	--	72.8
4-pound cuts, unfrozen (F):												
Oven-braised at 300°................................	4	3.98	73.0	59.3	4.2	3.8	168.0	42.2	209°	41.0	26.0	58.5
Pressure-braised at 10 pounds (240°) in 59 ml. water..	4	3.92	70.1	57.0	5.8	3.5	105.0	26.8	216°	36.0	16.0	63.3
4-pound cuts, refrigerator thawed (F):												
Oven-braised at 300°................................	2	3.89	72.1	56.6	2.5	5.5	138.0	35.5	209°	40.0	25.5	60.0
Pressure-braised at 10 pounds (240°) in 59 ml. water..	2	3.83	72.4	54.4	2.0	4.5	111.0	29.0	216°	42.0	12.0	58.0

BOTTOM ROUND

Steer:											
3/4-inch-thick cuts (G):											
Range-braised at 212° in 1 cup water, after browning..	4	0.61	70.0	53.8	8.8	12.5	45.0	75.0	--	41.0	--	59.0
Broiled, well done..................................	4	.62		54.2		11.3	35.0	56.0	--	41.0	--	59.0
1-1/2-inch-thick cuts (A):												
Oven-braised at 300° in 30 ml. water, after browning..	2	2.06	69.2	51.4	9.2	19.3	70.0	34.0	185°	31.0	21.4	69.0
Roasted at 250°.....................................	2	1.98		53.1		16.1	425.0	215.2	185°	34.0	2.1	66.0
Roasted at 300°.....................................	2	1.80		55.1		17.4	124.0	69.4	185°	26.2	4.3	73.8
1-1/2-inch-thick cuts (A):												
Oven-braised at 300° in 30 ml. water, after browning..	2	1.98	70.2	54.7	8.2	16.0	67.5	34.1	185°	26.8	18.2	73.2
Pressure-braised at 5 pounds (227.1°) in 30 ml. water, after browning..............................	2	1.66		56.4		11.7	35.0	21.1	185°	32.7	19.1	67.3
Pressure-braised at 10 pounds (240°) in 30 ml. water, after browning..............................	2	2.14		52.6		14.8	35.5	16.6	185°	34.6	19.8	65.4
Pressure-braised at 15 pounds (250°) in 30 ml. water after browning..............................	2	1.72		55.8		11.0	36.0	20.9	185°	37.0	19.8	63.0
1-1/2-inch-thick cuts (D):												
Oven-braised at 300° in 30 ml. water, after browning..	8	1.85	73.6	58.3	2.6	5.3	37.7	20.4	176°	29.9	--	70.1
Pressure-braised at 10 pounds (240°) in 20 ml. water after browning..............................	8	1.91		57.2		5.7	12.2	6.4	176°	30.8	--	69.2
1-1/2-inch-thick cuts, biceps femoris (B):												
Range-braised in 50 ml. water, after browning.........	12	.92	71.2	58.8	7.5	10.1	51.2	56.0	176°	33.3	19.2	66.7
Broiled on rack with temperature maintained at 350°...	12	1.02	70.7	56.4	7.6	7.6	91.7	90.0	176°	39.7	5.7	60.3
1-1/2-inch-thick cuts, biceps femoris (B):												
Oven-braised in 350° oven, without browning or liquid.	4	.97	71.7	59.2	7.1	7.2	60.2	62.0	176°	37.2	19.1	62.8
Roasted at 350°.....................................	4	.91	69.6	56.7	8.5	6.0	132.5	146.0	176°	40.9	2.5	59.1
2-1/2-inch-thick cuts (G):												
Range-braised at 212° in 1 cup water, after browning..	6	2.24	66.2	52.0	14.0	20.4	82.0	40.0	208°	36.0	--	64.0
Roasted at 302°.....................................	6	2.07		55.6		13.2	190.0	96.0	176°	37.0	--	63.0
3-inch-thick cuts, semitendinosus (B):												
Oven-braised at 300° in 30 ml. water, after browning..	12	.84	70.8	58.7	7.6	10.5	73.3	87.0	176°	33.9	21.9	66.1
Range-braised in 30 ml. water, after browning.........	12	.81	70.2	58.4	8.3	10.6	78.8	97.0	176°	32.6	12.9	67.4
3-inch-thick cuts, semitendinosus (B):												
Oven-braised at 300° without browning or liquid.......	4	.84	70.7	56.3	7.2	13.9	86.8	103.0	176°	33.6	15.91	66.4
Roasted at 300°.....................................	4	.82	71.0	58.7	7.0	11.3	121.0	148.0	176°	32.1	6.56	67.9
Cow:												
1-inch-thick cuts, semitendinosus (E):												
Oven-braised at 250° in 50 ml. water, after browning..	30	0.48	--	--	--	--	20.7	43.1	176°	36.0	--	64.0
Roasted at 450°.....................................	30	.48	--	--	--	--	16.2	33.8	160°	28.2	--	71.8
1-inch-thick cuts, biceps femoris (E):												
Oven-braised at 250° in 50 ml. water, after browning..	42	.85	--	--	--	--	23.5	27.6	176°	29.4	--	70.6
Roasted at 450°.....................................	42	.81	--	--	--	--	14.5	17.9	160°	21.7	--	78.3
4-pound cuts, unfrozen (F):												
Oven-braised at 300°................................	4	3.75	71.8	58.3	3.2	8.2	163.0	43.5	209°	39.0	18.5	60.3
Pressure-braised at 10 pounds (240°) in 59 ml. water..	4	3.93	72.8	58.7	4.0	6.2	125.0	31.8	216°	41.0	9.5	58.5

See footnotes at end of table.

TABLE 43. --Cooking time, shrinkage, and yield of cooked meat as related to cooking method, moisture, and fat content of beef of Good grade and below--Continued

Description of beef, station code,[1] and cooking method (°F.)	Cuts	Weight of cut	Moisture content		Fat content, moist basis		Cooking time		End-point temperature	Cooking shrinkage		Yield of cooked cut[3]
			Raw	Cooked	Raw	Cooked	Total	Per pound		Total[2]	Drippings	
BOTTOM ROUND--Continued												
Cow--Continued												
4-pound cuts, refrigerator thawed (F):	*Number*	*Pounds*	*Percent*	*Percent*	*Percent*	*Percent*	*Minutes*	*Minutes*	°F.	*Percent*	*Percent*	*Percent*
Oven-braised at 300°	2	4.10	72.2	54.8	2.5	8.5	160.0	39.0	209°	43.0	21.0	57.0
Pressure-braised at 10 pound (240°) in 59 ml. water	2	4.21	72.0	53.7	2.5	7.5	122.0	29.0	216°	47.0	14.5	53.5
CHUCK												
Steer:												
3/4-inch-thick cuts (G):												
Range-braised at 212° in 1 cup water, after browning	2	.63	71.7	55.6	7.6	11.5	45.0	72.0	--	41.0	--	59.0
Broiled, well done	2	.53		54.4		11.7	34.0	65.0	--	42.0	--	58.0
1-1/2-inch-thick inside cuts (D):												
Oven-braised at 300° in 30 ml. water, after browning	16	3.58	--	--	--	--	81.0	22.7	176°	32.3	--	67.7
Pressure-braised at 10 pounds (240°) in 20 ml. water, after browning, for 10 minutes per inch of thickness	16	3.75	--	--	--	--	18.0	4.7	--	33.0	--	67.0
2-1/2-inch-thick cuts (G):												
Range-braised at 212° in 1 cup water, after browning	6	2.07	70.7	59.4	10.0	10.6	66.0	32.0	199°	34.0	--	66.0
Roasted at 302°	6	2.05		57.6		12.4	200.0	98.0	176°	36.0	--	64.0
3-inch-thick inside cuts (D):												
Oven-braised at 300° in 30 ml. water, after browning	18	3.92	72.6	54.9	5.8	12.8	129.0	32.9	176°	32.4	--	67.6
Pressure-braised at 10 pounds (240°) in 20 ml. water, after browning, for 15 minutes per inch of thickness	18	3.94		56.3		12.0	57.0	14.5	--	31.7	--	68.3
3-inch-thick outside cuts (D):												
Oven-braised at 300° in 30 ml. water, after browning	18	3.90	73.7	57.4	4.1	9.9	137.0	35.2	176°	31.0	--	69.0
Pressure-braised at 10 pounds (240°) in 20 ml. water, after browning, for 15 minutes per inch of thickness	18	3.61		57.8		8.2	54.0	14.9	--	30.3	--	69.7
Cow:												
4-pound cuts, unfrozen (F):												
Oven-braised at 300°	4	4.17	71.4	55.3	10.0	8.2	148.0	35.5	209°	40.0	22.8	59.5
Pressure-braised at 10 pounds (240°) in 59 ml. water	4	3.97	69.0	56.9	7.5	8.2	92.0	23.0	216°	42.0	12.8	58.2
4-pound cuts, refrigerator thawed (F):												
Oven-braised at 300°	2	4.00	71.8	53.4	5.5	8.5	135.0	34.0	209°	33.0	22.5	67.0
Pressure-braised at 10 pounds (240°) in 59 ml. water	2	4.36	70.4	52.4	6.5	9.5	120.0	27.5	216°	45.0	17.0	55.0
RUMP												
Steer:												
3-inch-thick cuts (D):												
Oven-braised at 300° in 30 ml. water, after browning	7	4.40	--	--	--	--	275.0	62.4	176°	33.7	--	66.3
Roasted at 300°	7	4.00	--	--	--	--	165.0	41.2	176°	34.7	--	65.3
3-inch-thick cuts (D):												
Oven-braised at 300° in 30 ml. water, after browning	12	4.52	--	--	--	--	162.0	35.9	176°	30.2	--	69.8
Pressure-braised at 10 pounds (240°) in 20 ml. water, after browning, for 15 minutes per inch of thickness	12	4.37	--	--	--	--	56.0	12.8	--	24.8	--	75.2

Steer:												
3-inch-thick cuts (D):												
Oven-braised at 300° in 30 ml. water, after browning..	12	3.01	--	--	--	--	123.0	40.9	176°	31.4	--	68.6
Pressure-braised at 10 pounds (240°) in 20 ml. water, after browning, for 15 minutes per inch of thickness..	12	3.06	--	--	--	--	43.0	14.2	--	26.4	--	73.6
LOIN												
Steer:												
3/4-inch-thick cuts (G):												
Range-braised at 212° in 1 cup water, after browning..	12	.61	64.8	46.6	16.8	28.2	45.0	79.0	--	34.0	--	49.0
Broiled, well done..................................	12	.57		49.6		20.6	35.0	63.0	--	39.0	--	44.0
2-inch-thick cuts (D):												
Oven-braised at 300°, without added liquid...........	31	2.49	--	---	---	--	86.0	34.7	176°	25.6	--	[4] 74.4
Broiled...	31	2.51	--	--	--	--	90.0	35.8	176°	36.5	--	[4] 63.5
2-1/2- and 3-inch-thick cuts (G):												
Range-braised at 212° in 1 cup water, after browning..	4	2.42	56.8	47.1	27.1	30.0	75.0	31.5	199°	28.0	--	62.7
Roasted at 302°.....................................	4	2.94		41.4		35.4	218.0	77.0	176°	36.0	--	52.0
SIRLOIN												
Steer:												
1-1/2-inch-thick cuts (D):												
Oven-braised at 300°, without added liquid...........	13	3.82	--	--	--	--	62.0	16.1	176°	25.5	--	[4] 74.5
Roasted at 300°.....................................	13	3.48	--	--	--	--	174.0	50.0	176°	37.6	--	[4] 62.4
1-1/2-inch-thick cuts (D):												
Oven-braised at 300°, with added liquid...............	29	3.52	--	--	--	--	64.0	18.2	176°	28.8	--	[4] 71.2
Pressure-braised at 10 pounds (240°.) in 20 ml. water, after browning, for 10 minutes per inch of thickness..	29	3.26	--	--	--	--	16.0	5.0	--	29.9	--	[4] 70.1
SIRLOIN TIP												
Steer:												
1-1/2-inch-thick cuts (D):												
Oven-braised at 300°, without added liquid...........	21	2.54	--	--	--	--	66.0	26.0	176°	35.9	--	64.1
Pressure-braised at 10 pounds (240°.) in 20 ml. water, after browning, for 10 minutes per inch of thickness..	21	2.56	--	--	--	--	16.0	6.4	--	35.4	--	64.6
1-1/2-inch-thick cuts (D):												
Oven-braised at 300°, without added liquid...........	10	2.24	--	--	--	--	52.0	23.0	176°	36.5	--	63.5
Pressure-braised at 10 pounds (240°.) in 20 ml. water, after browning..............................	9	2.17	--	--	--	--	13.0	6.2	176°	34.7	--	65.3
RIB												
Steer:												
2-1/2- and 3-inch-thick cuts (G):												
Range-braised at 212°, in 1 cup water, after browning................................	8	2.45	63.1	51.1	18.6	25.6	74.0	32.0	199°	26.0	--	[5] 69.6
Roasted at 302°.....................................	8	2.10		51.7		20.7	192.0	93.0	176°	33.0	--	[5] 61.9
3-rib cuts (D):												
Oven-braised at 300°, without added liquid...........	12	8.66	72.6	58.2	4.7	10.4	272.0	31.4	176°	28.0	--	[4] 72.0
Roasted at 300°.....................................	12	8.52		60.4		9.2	309.0	36.3	176°	28.9	--	[4] 71.1

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[1] See table 30, footnote 1, page 48.

[2] Includes percent weight loss in evaporation and drippings.

[3] Figures for boneless cuts are calculated by subtracting shrinkage loss from 100 percent.

[4] Yield of cooked cut with bone.

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